lonial," "Plastic Baroque," and the "Navaho Look." Prices vary: it was possible to get an inflatable chair for as little as 59¢; an easy chair now sold that is part Swedish but features Japanese electronics in its stereo head-sets and a German impeller motor for a rippling motion in the back rest, sells for a cool $16,500 each. Aesthetically, as well as for many specific functions of use, or telesic aptness, there are probably at least 500 "good" chairs. But we might concern ourselves with 3 chairs I consider great, 2 of which have stood the test of time so well that most people are astounded when they find out when these chairs first came into being.

The Director Chair in its most current version is a scissor-legged wooden construction with slip-on seats and back, made of No. 8 duck, with a 300-pound test strength. It is extremely comfortable to sit in for long periods of time, and that is quite unusual for a chair without cushions or pads. For storage or ease of shipping, it folds up into a compact package, weighing less than 15 pounds. It has another unusual advantage in that it can serve equally well as an easy chair, desk chair, lounge chair, or dining chair. We use eight of them in our home, their light weight, compactness, and ease of maintenance together with great comfort and low price making them especially attractive chairs for today's greater mobility and changing life styles. At present, the chair can be bought from Sears Roebuck for $12.88. Jay Doblin, in his book *One Hundred Great Product Designs,* calls it ". . . a tremendous buy, probably the best dollar's-worth of furniture available." Most people, when asked to put a date to it, assume that it was designed during the late forties. They are mistaken by one century. The chair can be seen in early French and American photographs and reappears more frequently in pictures made during the Civil War. In its present form it is produced by a number of firms: the Telescope Folding Furniture Company of Granville, New York, and the Gold Medal

LEFT: Director Chair, manufactured by The Telescope Folding Furniture Co., Inc., Granville, New York.

BELOW: "Lounge Chair" (1938) by Durchan Bonet and Ferrari-Hardoy. Metal rod and leather. Manufactured by Artek-Pascoe, Inc. Collection The Museum of Modern Art, New York, Edgar Kaufmann Fund.

Company of Racine, Wisconsin, now make at least 75,000 chairs annually. Estimates made by current producers of the chair put the quantity produced since 1900 in excess of 5 million in the United States alone. Joy Doblin mentions that the Gold Medal Company can trace their present model back to 1903. In addition, there exist British, German, Swedish, and Finnish versions of this chair. The British version, tatted up for present-day consumers in leather and walnut, is sold as the "British Campaign Officer's Chair."

In 1940 Hans Knoll purchased the design of a chair developed by Ferrari-Hardoy and Durchan Bonet. This construction of 2 interlinking, open tetrahedra made of steel rods, covered with a sling of leather or canvas, has since become known as the Hardoy Chair among designers, as the Butterfly Chair, Campaign Chair, Sling Chair, or Egg-Head's Delight, and Safari Chair to the general public. It is an extremely comfortable indoor-outdoor easy chair, com-

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pletely amphibious when using the canvas sling, lightweight and, while not foldable in most models, at least stackable. The original Knoll-Hardoy retailed for $90 in 1940 with a leather sling. Rip-offs by competing manufacturers brought that price down, at least on the West Coast, to $3.95 in 1950. Overproduction of these rip-offs finally made the chair into a free giveaway at some supermarkets in the West and Southwest (with a purchase of $40 worth of groceries). The origins of the Hardoy Chair are obscure, but it was produced in a wooden version that folded, by the ubiquitous Gold Medal Furniture Company of Racine, Wisconsin, as early as 1895. Nearly 7 million Hardoy Chairs, or their copies, have been sold during the last three decades. The reasons for its popularity are identical to those for the Director Chair mentioned above; like it, the chair has resisted any attempt to infuse it with elements of "status" or "elitism."

"The Sack," designed by Piero Gatti and Cesare

"Sacco" (the Sack) Chair, designed by Piero Gatti, Cesare Paolini, and Franco Teodoro.

Paolini, was introduced to the Italian public late in 1968. Essentially, it is a leather-covered sack filled with plastic grains. The original retail price (in Italy) was \$80. Their chair is lightweight, essentially bag-like, and easy to carry. The consistency of the plastic fill is such that it molds itself to the user's contours. Except for the covering material, the chair also has no connotations of status. Since its introduction, copies of it, in various covering materials, have brought the price down to as little as \$9.99. It seems to work better in fabric, best in the original soft and pliable Italian glove leather. The internal mix of plastic pellets, with a covering of vinyl or Naugahyde, is probably the least pleasing because it doesn't "breathe." Like the Director's Chair and the Hardoy Chair, it fits in superbly with today's ideas of casual living. The disadvantage of The Sack and the Hardoy Chair is that older people find it hard to get in and out of them. What the three chairs seem to have in common (in spite of having been designed over the span of more than a century) is ease of maintenance, easy storage and portability, no concessions to status, and a low price. In this connection, it is interesting to note that, at least in the United States, none of these 3 chairs has sold to low-income markets. The reason is not obscure: the low-income groups have been successfully victimized by advertising and TV to feel that these are not "proper" chairs.

Designers may be far from unanimous in picking these 3 chairs as "good design." The "taste-makers" in our society have a disastrous record in selecting what is good design. The Museum of Modern Art, in New York, is usually credited as being the prime arbiter of good taste in designed objects. To these ends, the museum has caused 3 pamphlets to be published during the last 36 years. In 1934 they published a book entitled *Machine Art*. It is a heavily illustrated guide to an exhibition that was to make machine-made objects palatable to the public, and moreover the museum hand-picked these objects as "aesthetically

valid." Of 397 objects thought then to be of lasting value, *396* have failed to survive. Only the chemical flasks and beakers, made by Coors of Colorado, still survive in today's laboratories (after enjoying a brief vogue that was museum-induced, during which the intelligentsia used them as wine decanters, vases, and ashtrays).

In 1939, the museum held a second exhibition; the pamphlet *Organic Design* illustrates the various entries. Of 70 designs, only one, entry A–3501 designed by Saarinen and Eames, saw further development. The box score of the 1939 exhibition was zero. However, entry A–3501 was parlayed into two competing chairs by its two respective designers. The Saarinen Womb Chair of 1948 and the Eames Lounge Chair of 1957 are both spin-offs of that exhibition entry.

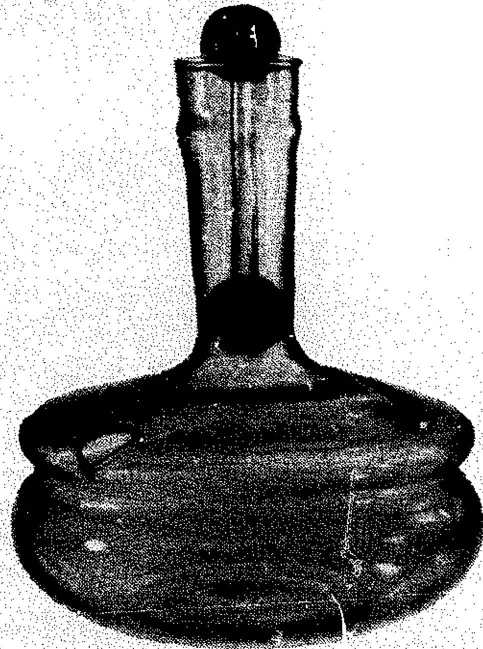
In 1950 an international exhibition under the title "Prize Designs for Modern Furniture" was held at the museum. In spite of the fact that most of the entries were made this time by corporate design staffs and furniture companies, only one of 46 designs survives to this day. Since the Saarinen and Eames Chairs mentioned above sell for $400 and $654 respectively, their real impact on people has been negligible. But when we deal with the taste-making *apparat* of the Museum of Modern Art, a score of 3 successes and 510 misses is far from reassuring. What is even more impressive is what the museum has missed: Mies van der Rohe's Barcelona Chair was designed in the twenties. Knoll International revived the chair in the fifties, sold it (only in pairs) at $750 *each:* it has since become the prime status symbol of big business and graces the entrance hall of most gauleiters of industry around the world. Another one missed by the museum, and equally profitably reintroduced by Knoll, was the canvas and steel Le Corbusier Chair, also originating in the twenties.

It is most interesting to compare the many museum catalogues of "well-designed objects." Whether printed in the twenties, thirties, fifties, or seventies,

"Chemex Coffee Maker" (1941) by Peter Schlumbohm. Pyrex glass, wood, 9" high, manufactured by Chemex Corp., U.S.A. Collection The Museum of Modern Art, New York. Gift of Lewis and Conger.

the objects are usually the same: a few chairs, some automobiles, cutlery, lamps, ashtrays, and maybe a photograph of the ever-present DC-3 airplane. Innovation of new objects seems to go more and more towards the development of tawdry junk for the annual Christmas gift market, the invention of toys for adults. When plugging in the first electric toasters in the twenties, few would have foreseen that in another brief 50 years, the same technology that put a man on the moon would give us an electric moustache brush, a battery-pack-powered carving knife for the roast, and electronic, programmed dildos. ("Joy to the World?") But there have been true originators. I can find nothing designed by the late Dr. Peter Schlumbohm that is not supremely well designed, thoughtfully engineered, a complete breakthrough, and unusually attractive aesthetically.

Dr. Schlumbohm was a self-employed inventor who in 1941 designed the Chemex Coffee Maker. The Chemex was to be prophetic of all Schlumbohm's later designs: a way of doing things better, more simply, and through non-electric, usually non-mechanical means.



"Water Kettle" (1949) by Peter Schlumbohm. Pyrex glass, 11" high, manufactured by Chemex Corp., U.S.A. Collection The Museum of Modern Art, New York. Gift of the manufacturer.

By restudying applied physics, he was able to develop a way of making better coffee more simply. Since its introduction in 1941, many copies of the Chemex system have appeared in other countries, notably the "Melitta" in Germany, as well as several Swedish systems. The coffee maker was followed in 1946 by a cocktail shaker, in 1949 by a glass water kettle that boils water faster because of its configuration, in 1951 by an electric "filter-jet" fan, and by many other items such as snow goggles, a dual-purpose tray, etc. Everything designed by Schlumbohm (who died in 1957) was reasonably priced.

It would be both repetitive and boring to list again the many badly designed toys. While we seem to have gotten away from some of the tin soldiers, bombers, and tanks for boys and wardrobed Barbie dolls for girls, we have instead intergalactic robots. Many of them are as destructive as the war toys, and even more inhuman and mechanistic.

One of the more successful Christmas toys during the 1970 holiday season was a little device selling under the name "Dynamite Shack." A small house made

of plastic came equipped with a bundle of (fake) dynamite sticks that were connected by a cable to a detonating device. The idea was for the eager children to sneak the bundle of dynamite sticks down the chimney and then press the detonator. After what the manufacturer called a "satisfying bang," the house would seemingly explode into a dozen or more pieces. Of course, these pieces could be reassembled, and the game could be played over and over again. But I must question both the educational and the entertainment value of a toy that teaches youngsters how to blow up buildings.

The number of toys that presently are well designed, inexpensive, and specifically related to the discovery cycles of a growing child is still somewhat small. But a start has been made. Creative Playthings, of Princeton, New Jersey, and Los Angeles, California, markets such toys from all over the world. I should especially like to commend a series of simple wooden toys from Finland.

These were designed to give both pleasure and training in such skills as twisting, turning, threading, pressing, pushing, etc. They are designed by Jorma Vennola and Pekka Korpijaakko. Several summers ago, Jorma Vennola, who was a student of mine, greatly helped in the invention, design, development, and building of the first portable play and training environment for children with cerebral palsy (CP–1). This environment is pictured and described elsewhere in this book. While working on the environment, Jorma Vennola also developed several toys. One of these is his "Fingermajig." As this is probably an ideal design development, let me describe it briefly.

Two plastic halves, each the exact shape and size of one of the halves of an old-fashioned bicycle bell, are connected into a ball-like configuration. Through a series of holes, a number of dowels protrude by about 1½ inches, each. They have backstops so that they cannot slide out. The heart of the device is a small foam rubber ball. When pushed, the dowels will move in and then jump back out again. The toy comes in

8 bright colors. Children love to play with it. It has a wonderful feel and resiliency. It provides superb exercise of the hand muscles for all children, as well as those with cerebral palsy, some types of paraplegia, and myasthenia gravis. Being extraordinarily simple and non-mechanical, it does not wear out or need repairs. It floats (making it accidentally one of the few well-designed bathtub toys). With its bright colors, it is a wonderful toy for play in the snow.

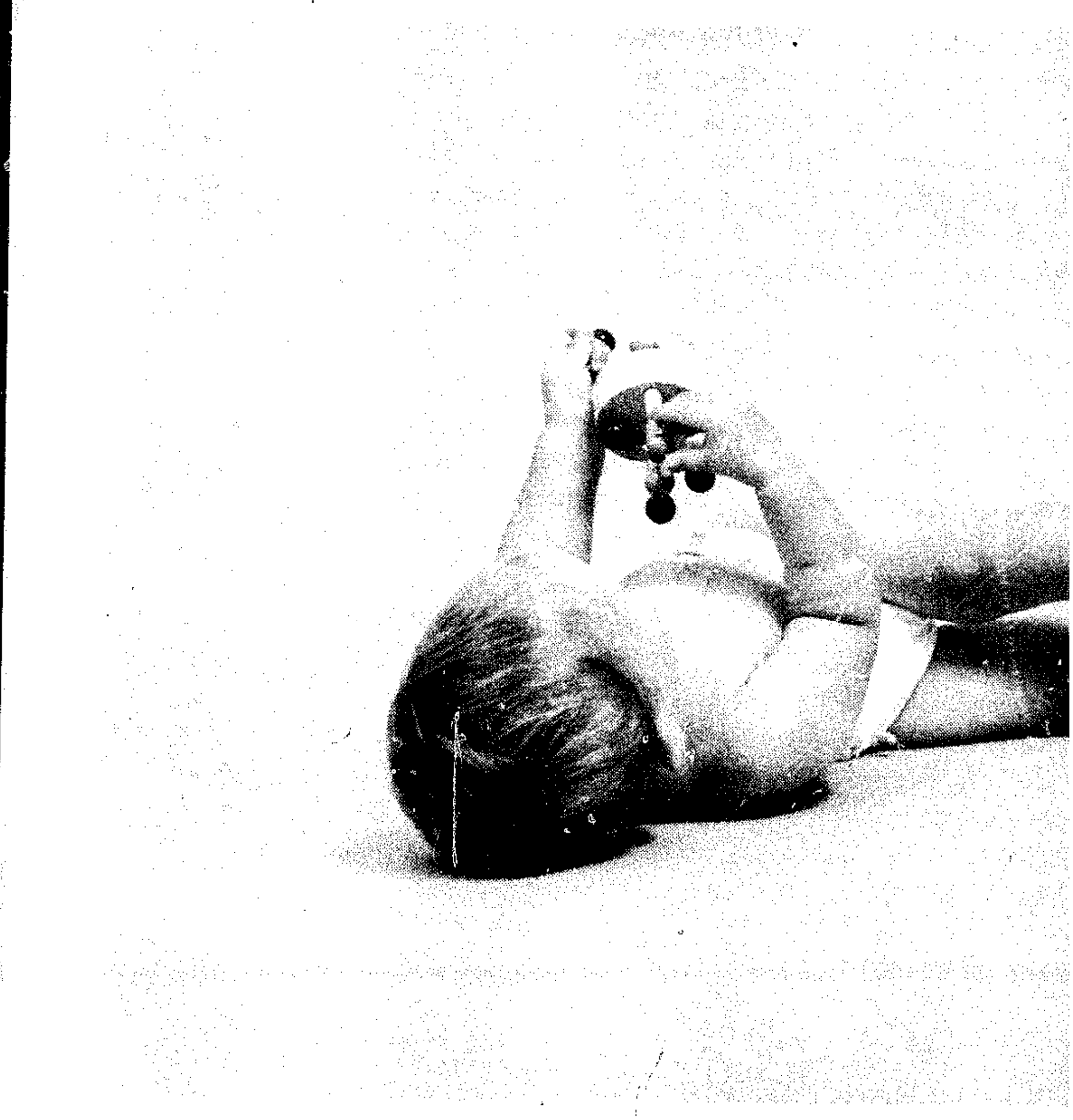
Best of all: after transportation charges from Finland and duty payments, it retails for 75¢. (Some stores, usually department stores, have lately taken to selling the "Fingermajig" as a toy for $1 in their children's department, and for $5 each upstairs as an "executive pacifier.") While Creative Playthings is to be commended for marketing these toys, much of the credit must go to Kaija Aarikka who first began producing and selling them in Helsinki.

There is much that is designed well, incredibly much more that is designed badly, and a truly frightening amount of things that are never designed at all. Now, I am not pleading for more and more products. A world with its back to the wall, ecologically speaking, can ill afford any of the four stages of pollution: the rape of raw materials, the pollution created in manufacturing, the overabundance of products, or the pollution of disused products rotting away. I am frightened when Herman Kahn quotes a song sung every morning by the Matsushita factory workers in Japan:

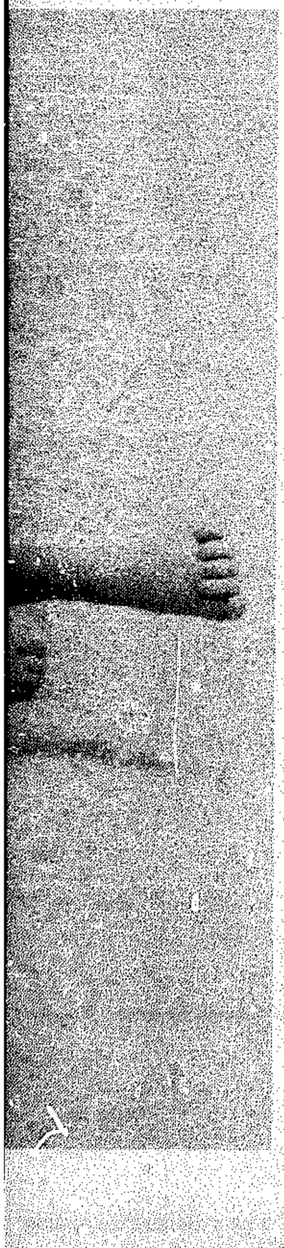
> Let's put our strength and minds together.
> Doing our best to promote production,
> Sending our goods to the people of the world
> *Endlessly and continuously*. . . . [my italics]

Nonetheless, there are things that are needed, things that are needed now. Often designers tend not to design something because a better technology seems on its way. But that is a cop-out. When a blind man needs a better writing tool for taking notes in Braille, then it is little use telling him that in 10 years, tape recorders the size of a cigarette pack will cost less than





"Fingermajig" (NEAR LEFT) and "Threading" (BELOW) toys designed by Jorma Vennola (Finland). "Turning" (FAR LEFT) and "Pushing" (BELOW LEFT) toys designed by Jorma Vennola and Pekka Korpijaakko (Finland). Courtesy of Creative Playthings, Princeton, New Jersey and Los Angeles, California.

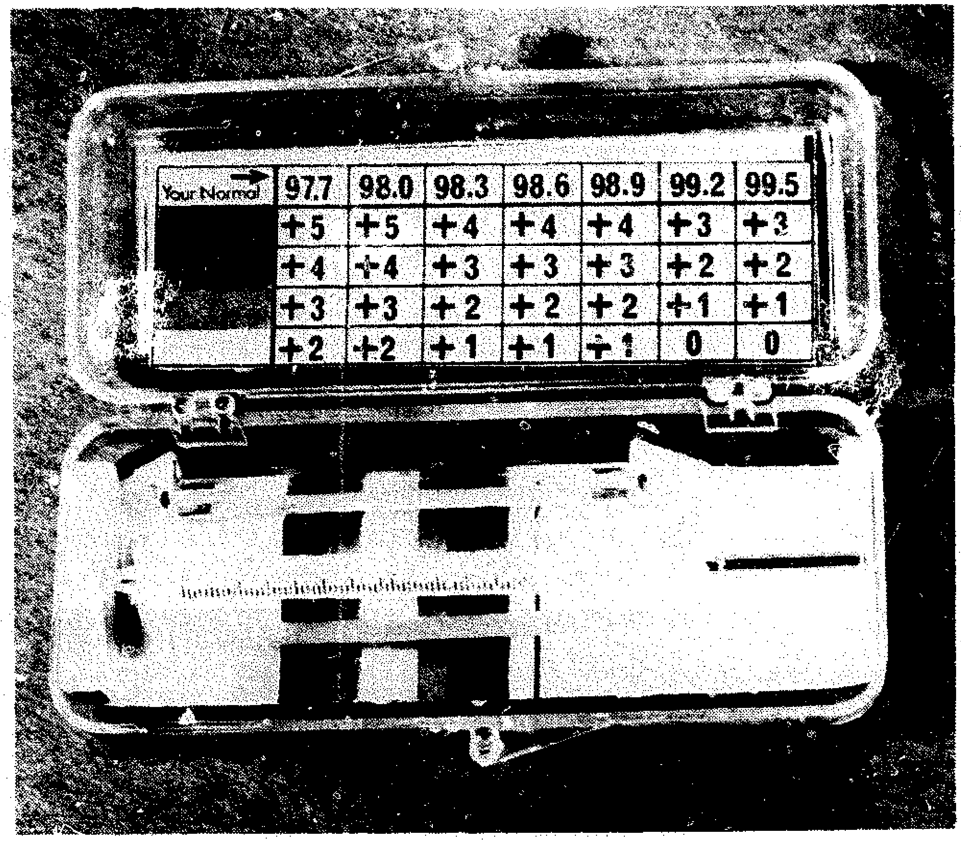


$10. First of all, he needs the writing tool *now*; secondly, present-day monopolistic practices make such projections of future price highly unlikely. After all, it is monopoly agreements and price-fixing that result in a hearing aid consisting of an earpiece and a pocket-sized amplifier which cost $6 to produce, to retail for $470. Because few designers seem to think up and develop the type of products really needed, I have explained about 100 of these in the passage to come.

(I must apologize for listing them in a sort of "designer's shorthand." To describe each and every product would fill many volumes. That others may have had similar ideas is a fact of which I am abundantly aware. However, they have done little or nothing about it. Some of these products have already been designed by some of my students and are illustrated in this book. What we are all looking for are ways of facilitating their production.)

PRODUCTS NEEDED NOW: Health care and disease prevention as well as diagnostics might be a good place to start. Of course, there is a need for intelligently designed heart-lung machines, simplified open-heart surgery, and much else. Instruments nearly that sophisticated, like the drills and saws for osteoplastic craniotomies designed by a student of mine, C. Collins Pippin, are illustrated elsewhere in this book. But much can be done on a much lower, almost "gadgety" level. Take fever thermometers, for instance. None exist at present that give an extremely fast, efficient readout and are low in cost. None exist that are color-coded so that people unfamiliar with writing, or with the convention of 98.6° being "normal," can find out what their temperature is. What about a thermometer that makes it possible for a blind person to take and determine his own temperature? One only exists; it is imported from Switzerland, breaks down often, and costs $20.

All of us have wasted too much of nurses' or nurses aides' valuable time as they tried to find our pulse and



A color-coded box with a linear magnifier holds the thermometer and permits readings by illiterates. Designed by Sally Niederauer, as a student at Purdue University.

then take it. Modern electronics could provide us with a pulse-taker that responds to the actual pulse vibrations. It could be about the size of an old-fashioned pocket watch and need cost no more than $15. One of my students, Bob Worrell, has in fact designed such a device. But here we encounter a second level of complexity. Many people who are perfectly capable of using such a device on patients may be functional illiterates and therefore incapable of reading a complicated dial, doing some arithmetic regarding pulse mode, and then transferring this data correctly to a patient's records. Obviously a digital read-out can be devised. To take it a step further, the digital read-out can be linked to a rubber stamp wheel, so that it can

be read (but need not be) and can be transferred directly to the appropriate chart. (In fact, labor unions and craft guilds have much on their books that is restrictive in this sense. Gas and electric meters, for instance, present a confusing array of 5 or 7 different dials in many communities. The union and/or the company then forces new men to undergo months of training in how to read these unreadable devices.)

Surely blood pressure can be taken more easily and more comfortably for anxiety-prone patients.

Urinalysis can be a gamble. One commonly used device works like a hydrometer, but because the scale inside the tube is printed on a piece of paper that is not firmly fixed, such readings are completely meaningless. This device sells for under $4. At the other end of the scale are vast electronic machines that do a good job in hospitals. These cost several thousand dollars. Humbert Olivari, a student of mine at North Carolina State, attempted to prove that it was possible to design a small electronic device that could be made for under $30, thus filling the mid-range of urinalysis devices through thermocouples.

Crutches are badly designed; braces are costly and not designed for greater adjustability to differing body proportions. Canes for the blind were recently redesigned for the first time by Robert Senn; they are described and pictured elsewhere in this book.

Exercising vehicles for children with cerebral palsy, paraplegia and quadriplegia, myasthenia gravis, and other debilitating diseases are fully discussed and illustrated in another chapter. Right now I am designing an exercising-and-fun vehicle for children who are only capable of uncontrolled gross body-movements. But what about such devices as exercising tools for middle-aged males facing stroke or coronaries? What about such devices for veterans newly fitted with prosthetic arms or legs? Such vehicles could be stationary, self-propelled, or used in water for hydrotherapy. It is sad to record that when my students and I designed our first vehicles of this sort in the late fifties, these

were then the only ones available anywhere. Since then only three badly restructured tricycles have been produced commercially.

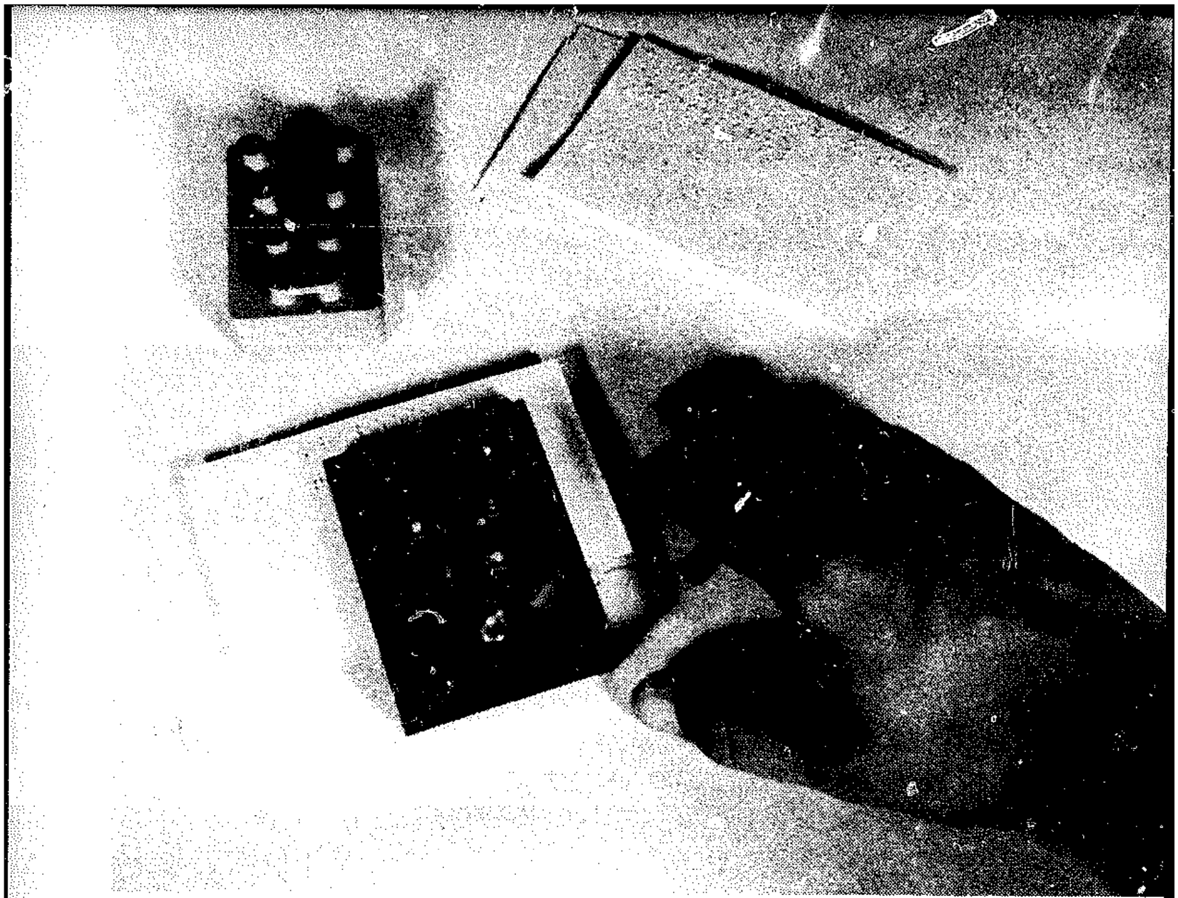
There is no diagnostic device for quickly, accurately, and inexpensively obtaining galvanic skin response. (A fountain-pen-sized probe would do the job.)

No really safe pillbox is currently manufactured at a cost low enough so that it can be given away with prescriptions. In the United States more than half a hundred children die annually because they overdose themselves with various pills and capsules. There is no "safe" for medicines kept in the home that is childproof. There is no "safe" for household cleaners and chemicals that is tamper-proof.

Blind adults need an instrument on which to take notes in Braille. At present they are faced either with using an expensive and bulky typewriter (since they cannot see, the typewriter needs extra controls), or using a wholly inadequate "pocket stylus and slate." This instrument is small enough to be carried. However, as the impressions are made in a *downwards* direction and Braille is *raised*, everything has to be written *backwards*. A team of two graduate students at Cal Arts, James Hennessey and Solbritt Lanquist, have designed an inexpensive, pocket-sized Braille writer. But blind people also need more meaningful work than making baskets and brooms. It could become the job of the designer to develop manufacturing processes directly related to the often impressive skills of the blind.

There are many other groups that we have singled out and called "deprived," "disadvantaged," or "retarded." By doing so we manage to blame them for the shortcomings of our society. Their skills must be investigated to lead to the design and development of things for them to do. It goes without saying that members of the disaffected groups must in each case be part of the design team.

When the San Francisco Museum of Art recently had a sculpture show for the blind, many were smil-



ingly impressed by the foresight and "creativity" of the museum's curator. Hordes of tiny blind children were marched through the galleries while the flashbulbs busily clicked away. But surely we cannot deprive the blind, and partially sighted, of all the heritage of sculpture, using their ailments only for occasional ego trips by museum directors. (By the way: the exhibition and the idea for it was borrowed from a show called "Art for the Blind," held at Moderna Museet in Stockholm in July and August, 1968. That show, however, was held in a totally blacked-out area, thus temporarily "blinding" even the sighted. All sculpture was identified in Braille; to go through the show one had to *feel* one's way along a waist-high rail. When one touched the Braille identification, a tiny, nearly invisible, wheat-germ bulb would light up, illuminating only a one-inch area that identified each object for those of us who could not read Braille. Quite a difference from the San Francisco show!)

FACING PAGE: Writing instrument for the blind that is a major improvement on models now existing. Designed by Solbrit Lanquist and James Hennessey, as graduate students at California Institute of the Arts.

LEFT: Pillbox designed to be tamperproof, so that small children are denied access to pills. Designed by David Hausman, as a student at Purdue University.

At present we are working on a "Sensory Stimulation Wall." I am indebted for the idea to a former student of mine, Charlie Schreiner of Purdue University, and Yrjö Sotamaa of Helsinki. Essentially the wall is a space grid measuring 2 x 5 feet and is one foot deep. "Plugged" into this wall are 10 one-foot cubes. Each "does" things. They squeak, show multifaceted reflections, are three-dimensional interior "feelies" for the hand to explore, switch on lights, and much else. This unit can live in the nursery or day-care center, lying on one of its 5-foot-long sides. Children as young as one year can explore the unit and play with it. As the child grows older or new skills develop, new types of cubes such as aquariums, rear-projection slide screens, electronic toys, and much else, can be added or substituted. Specific skills such as lacing, buttoning, tying, working a zipper or buckles, snaps, etc., can be taught.

The discomfort, pain, and puzzlement of a small

baby that is teething is really pathetic. After experiencing 4½ million years of this (according to Robert Ardrey), we have developed *one* toy: a plastic tube filled with water that can be frozen. It gives the baby comfort for about 5 minutes, by which time it has warmed up and is therefore no longer soothing. Surely we can do better than that.

According to the best estimates there are at present about 150 million people (world-wide) who are bed-ridden, would like to read, but cannot turn the pages of a book. Seven different "page-turners" are available in Sweden, 3 in the United States; none of them work. After designing one, we might also link it to a small overhead opaque projector.

The aged need furniture that is easy to get into or out of. This furniture should be low in cost, easy to clean, and easy to maintain. In the retirement villages of Florida and the West Coast there live hundreds of cabinet-makers, designers, and craftsmen, whose most challenging stimulus is the weekend Canasta tournament. The furniture can be designed and built by the client group involved.

What are meaningful, constructive games for the elderly? Surely shuffleboard is not the only option.

Handicapped people, the elderly, and some children need walking aids. All walkers available at present are dangerous, unwieldy, and expensive. *Any* compassionate and well-trained fourth-year design student could design a better walker than any that are now available, in less than one hour.

It seems that a large number of people whose eyesight is less than perfect cannot wear contact lenses. Eyeglass frames change from year to year. But what about self-adhering glasses that attach to the temples, greater peripheral vision, glasses that change color (for bright sunlight, snow, night driving, etc.) chemically?

An ambulance can cost as much as $28,500. Where are well-designed, low-cost inserts that would convert any station wagon to an ambulance for use during

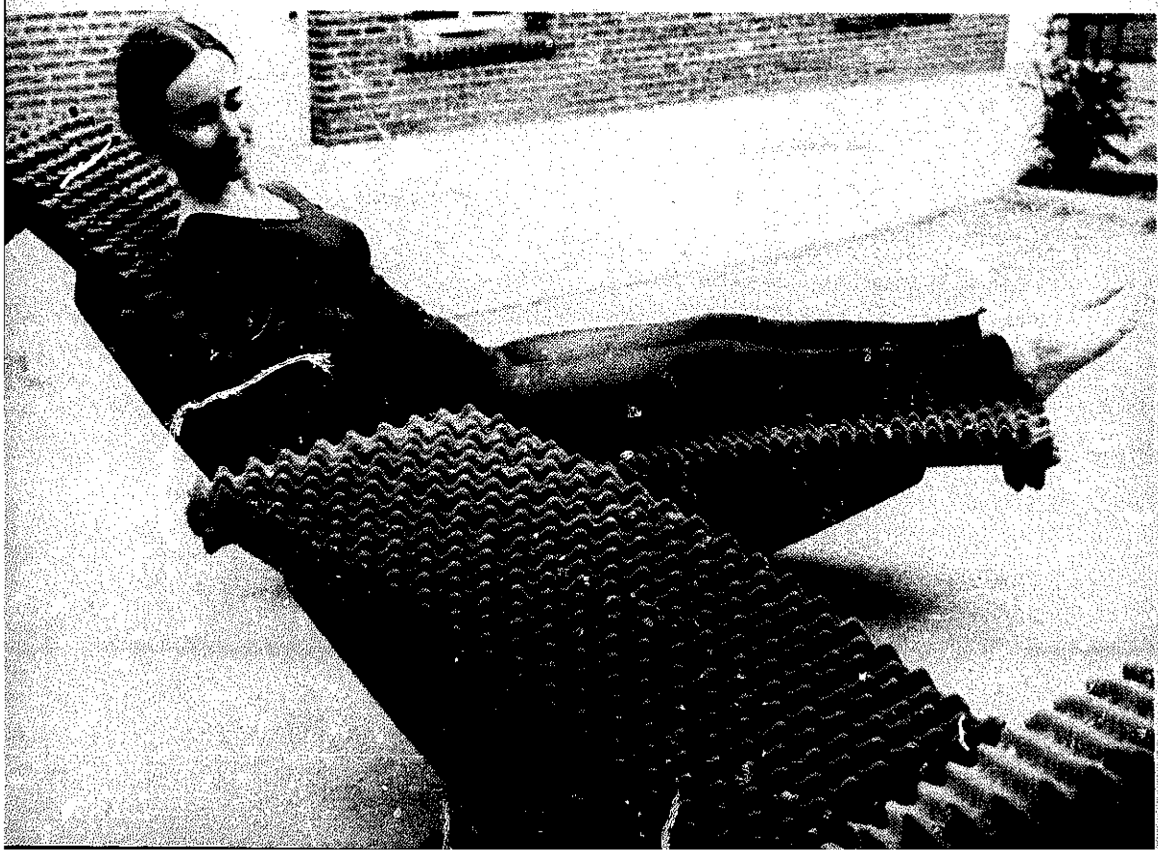
a national emergency? With the number and prices of ambulances now, this particular national emergency began about 20 years ago!

In a later chapter an environmental exercising and play cube that was built for handicapped children in Finland is pictured and discussed. What about other cubes? Experimental cube child-care centers, cubes that can be used under water and mid-water, and knock-down cubes that can be used for play, testing, and diagnostic purposes? When university students (another exploited group) move into an old apartment, they needlessly spend much money to make it inhabitable. The services of such an apartment are often indispensable: running water, a toilet and bathtub, heating, a kitchen complex, windows, and room for storage. Much money and time is spent on painting walls and floors, paint that eventually remains behind as an improvement for the slum landlord. And of course there are many people living in slums who cannot afford any improvements. Interior living cubes can be constructed that will make it possible to combine sleeping, working, and sitting surfaces into an aesthetically manageable entity that uses all of the resources of the apartment itself in an ancillary way only, but shuts them out visually. Friends of mine have constructed three such cubes (one to sleep, eat, and entertain in; one for work; and one as a play environment for the baby; each 8 feet cubed) and installed them in their rambling, ugly, slum apartment in Chicago. Recently they have moved the cubes (knocked-down and packaged flat) to a new, equally expensive and ugly tenement in Buenos Aires.

Nearly two years ago, experiments carried on at *Konstfackskolan* in Stockholm and fully documented in the Swedish design magazine, *Form*, have shown that people in wheel-chairs cannot use pay telephones or revolving doors, or buy articles of their choice in a supermarket. Much of this also holds true for people on crutches. But nearly two years have passed now. Where are the pillar-telephones (with an acoustical

hush-umbrella) for the handicapped? Where are inexpensive but durable conversion units that will change sidewalk steps and curbs into ramps? Where are the revolving display units for supermarket merchandise?

Thornton Ladd's Pasadena Art Museum, completed in 1970 and accurately described in *Time* (May 24, 1971, p. 68) as "a regrettable hybrid of cruise-ship lounge and California bathroom," makes no concessions to the very young, the elderly, or the disabled. Steps must be used to enter it, to leave it, or, once within, to go to the lower level: there are no ramps anywhere. The colossal doors would defeat anyone on crutches or in a wheel-chair (always assuming they were carried up the steps). Small children in prams or strollers are out of luck, as are their unfortunate parents. The floors are slippery for anyone attempting to maintain a precarious balance with the aid of a cane: elderly people, who make up an unusually sizable portion of Pasadena's population; women who are pregnant and somewhat unsteady; young people with, say, a temporary skiing injury: in short, those who might be expected to have enough disposable leisure time to come to the museum. The ground out-

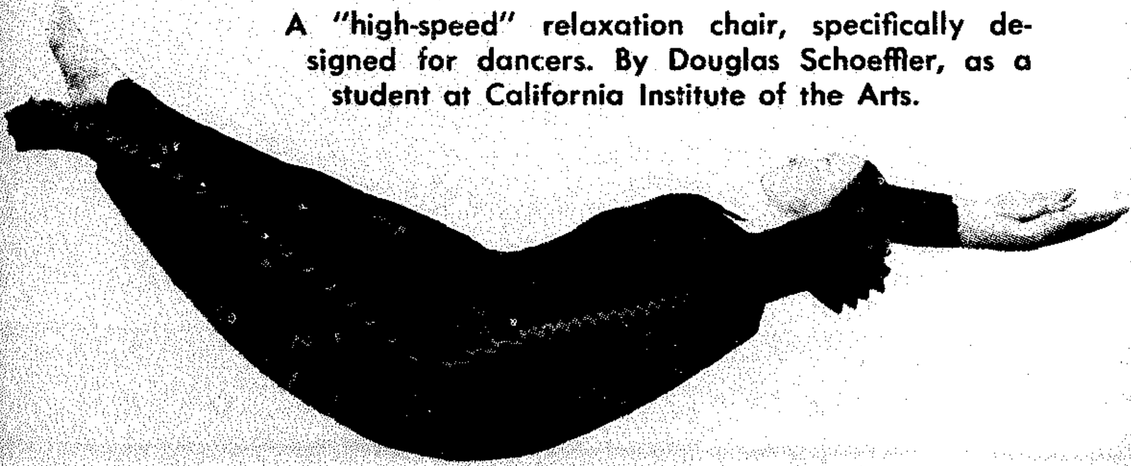


side the museum is surrounded by a sort of optical moat: crushed white marble and crystal glitters in the unshaded sun in mind-blinding harshness. After passing this visual booby-trap, even the healthy need quite a while before their eyes adjust enough to be able to see some of the colors of the paintings inside.

In a splendidly engineered, vertical black slum in Chicago, black women are forced to walk a round trip of nearly five miles to shop at the nearest supermarket. Public transport is unavailable. If a woman is pregnant, she has to rest her parcels on the head of her unborn baby on the way back. The architectonic and hydraulic problems of pregnancy are also permanent problems of the obese. Simple chores such as taking a bath and getting out of bed create a host of imbalances. Yet, the tools of making life easier for these people have not been forthcoming.

Highly specialized work often calls for highly specialized equipment. As a case history: At Cal Arts we discovered that dancers and dance students could relax their legs more efficiently by elevating them as much as possible. No seating unit (with the partial exception of the ill-fated "Barca" Lounger of 1939)

A "high-speed" relaxation chair, specifically designed for dancers. By Douglas Schoeffler, as a student at California Institute of the Arts.



exists for this function. By making dancers and dance students (the client group) part of the design team, a graduating student, Douglas Schoeffler, developed a relaxing chair that does the job. In the first picture it is shown in a normal seating position. In this mode it can also be used like a rocking chair. In the second illustration it is in a "high-speed relaxation" mode. Just by putting one's arms behind one's head, one tilts the chair to the second position. Many of these chairs have been built and sold to professional dancers or students at cost. It also helps relax the tired legs of waitresses, nurses, etc.

Safety and consumer protection could (and does) fill many volumes. What interests me most is how *unsafe* most safety devices are. Safety glasses, goggles, helmets, shoes, and truck drivers' cabs have been mentioned in Chapter Four. In addition, there is a problem with hydraulic dollies, which we use when moving heavy objects in order to escape injury. These are overpriced by, minimally, 600 per cent. Also, noise pollution not only affects hearing, but has been demonstrated to have bad effects on the cardiovascular system. Ear protectors, even when designed for gun enthusiasts, are unsafe, outmoded, and don't work well. There are no efficient smog masks. There are no efficient back supports, groin supports, girdles, and back braces for men in the construction industry. (Excellent designs for these exist in Eastern Europe. However, both our "captains of industry" and their captive designers seem to assume that "nobody ever really works that hard."

One of the most dangerous chunks of equipment available in the United States is the school bus. They are unsafe vehicles, and they give insufficient protection to children and driver. Local school boards seem to believe in cutting corners both literally and figuratively. The excellent German buses that exist for this purpose are not bought, and American transportation firms are unwilling to build a better vehicle. These 30-year-old death traps rattle down the twisting moun-

tain roads of North Carolina, where a local law permits them to be driven by fifteen-year-olds.

There is no well-designed first aid kit on the market.

Most farm accidents occur with tractors. Nearly all of them have no roll-bars.

All farm machinery and farm implements are unsafe.

With the number of boating accidents that affect small children and babies, it is amazing that no "automatic face-up" life vests exist.

There has been much talk about road safety. Bucky Fuller's Octahedral Truss (a structural system) would certainly make a better guard railing than anything now used. A research team of graduate students at Purdue, headed by Michael Crotty, proposed such a system in 1967. It was rejected as too costly. With an average of fifty thousand deaths a year, what does cost mean?

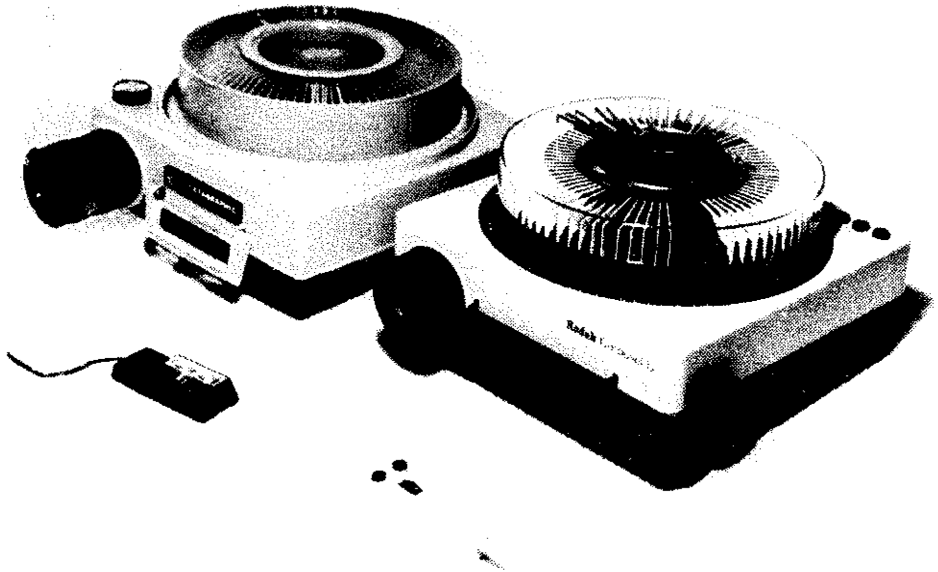
Road services are at fault here, too. In states like Indiana, the beading which connects narrow original roads with later 3-foot-wide increases in width becomes slick and treacherous when iced over.

Apparently, American motorists reject the idea of having a governor attached to their accelerator. But why not attach a device that activates a loud external siren or bell when the speedometer climbs above 70 mph? At least it would give the rest of us fair warning, and a chance to scuttle to safety.

Discrimination against the poor by designers and their employers is reflected in the pricing of many appliances and tools. Rather than designing an object that will sell at a reasonable price and work well, and then adding other choice options to it as the price rises, we seem to delight in a different approach. We have established a new cycle: the cheapest item in the line is usually virtually a toy (Polaroid Colorpack II). One step up in product cost and we reach the level of junk (most mixers and blenders). A further step

and we arrive where we should have been at the beginning: an honest piece of equipment, but vastly overpriced (the IBM Selectric Typewriter). But there are still a few more steps to go. The next one is usually the same piece of equipment as before but now "loaded" with extras. This is called *luxury* (any American automobile). Finally, we get basic design simplicity, usually well made and outrageously overpriced. This is status (the Mies van der Rohe Barcelona Chair). In this connection it might be instructive to use a case history.

A number of years ago, Kodak developed a gravity feed system for the slide magazines used in their slide projectors. A projector called the Kodak Carousel was developed. Because the method of handling slides was really excellent, and because the projector itself was of unusually rugged construction, it sold well. But as the dean of the American Industrial Design profession, Raymond Loewy, is so fond of saying, "never leave well enough alone." Soon a new Kodak Carousel model came off the drawing board, the "slim-line" model. Since it was more compact, many people bought it. The basic early model became the Carousel 600 (with push-button slide changing, a choice of lenses, a tray for one size of slide) for $60 (other size slide trays and several lenses available, extra). We proceed next to the 650 (added: accepts several sizes of slide, button changing forward and reverse, remote control forward) for $100; to the 750 (added: remote forward and reverse, a high-low lamp-saver switch) for $130; to the 800 (added: remote control focus, built-in timer) for $145; to the 850 (added: automatic focusing rather than remote, a tungsten-halogen lamp, 2 lenses included) for $190; to the 760 (with a larger slide tray than the 850, and a larger lens included) for $149.50; to the 860 (similar to the 850 but with remote focusing) for $200; to the 860QZ (zoom lens included) for $239; as well as a few other intermediary models with different combinations of accessories. The line even includes the RA960 (random access to slides) for $875



Two Kodak Carousel Projectors with remote focusing and control cords. The German Kodak Carousel "S" with variable voltage costing approximately $75 and equipped with extra heavy-duty wiring. The American Kodak Carousel Ektagraphic "VA," quite similar but heavier and without the voltage adjustments, awkwardly designed and heavier, $279.50.

and an arc slide projector for $1500 (with an arc light).

During all this time, however, Kodak has also made point-by-point copies of nearly all of these projectors and sold them under the name "Ektagraphic" to schools and audio-visual departments. The Ektagraphic line cost about $10–$20 more than their consumer's counterparts. There are only two differences between these and the consumer models: Ektagraphic projectors are painted gray rather than black, and they have what Kodak archly calls "sturdier wiring." This means that Ektagraphic projectors (generally not avail-

able to the public except through audio-visual stores) have a grounded (3-point plug), heavily insulated wiring, and are less liable to short circuits.

Or in other words: the regular consumer's models, selling from $60 to $239, *are not as safe* as the Ektagraphic line.

Meanwhile, back at Stuttgart, West Germany, Kodak has quietly built and sold their own version, called the Carousel "S." This model *is* safely wired, has its own remote focusing and slide-selection cables and, to top it all, has built-in step-down and step-up transformers that make it usable anywhere in the world, regardless of local voltage. It sells (in Germany) for a cool $75. Kodak of Rochester, New York, actively attempts to discourage Americans from buying it, hinting that it is somehow unsafe or unsuitable. This is, of course, untrue.

The German model communicates simple, safe, and accident-free function both through performance and looks. Should some German consumer wish to try for the miracles of zoom lenses, automatic timing, and what not, these options are simple plug-in components that can be bought separately later on. All the accessories that go with the German version of the Carousel, such as slide trays, extra lenses, etc., are also better designed, more solidly built, aesthetically more pleasing, and far less expensive. What is the point here? Well, the Germans seem to be using that good old American know-how: mass production. They make just *one* projector with plug-in options, whereas we make nearly a dozen (counting the Ektagraphic line), all slightly different from each other and all neatly trapping the consumer with his choice. Our system is designed for consumer dissatisfaction and forced obsolescence. That it is also expensive and unsafe has been demonstrated.

Of course, projectors need lenses too. In their June, 1971, issue, the magazine *Modern Photography* conducted a comparison lens test. All lenses were rated "excellent," "very good," "good," and "accept-

able"; they were rated according to center and edge definition.

The standard Kodak Carousel lens (5-inch F:3.5 Ektanar) received a rating of "acceptable" (read: "lowest") for center definition and "good" (read: "second lowest") for the edge definition. The Kodak zoom lens used in our example above was tested in three different positions; it was rated "acceptable" four times and "good" twice. By contrast the standard German Kodak Carousel lens (Projar, F:100mm) has been tested and rated "excellent" for both edge and center. The zoom lens for the German Kodak "S" (Vario-Projar, F:3.5, 70–120mm) has been rated as "excellent" for three and "very good" for the other three positions.

(It is interesting to note that of the six most popular lenses available in the United States and tested by *Modern Photography*, only one could be rated better than "second lowest": the sole German import on the list.)

In terms of the Third World, much needs designing. I must repeat that we cannot sit in plush offices in New York or Stockholm and plan things "for them" and "for their own good." Nevertheless, the purpose of this lengthy list is merely to interest people in what can and needs to be done. Power sources, light sources, cooling and refrigeration units, vermin-proof grain storage facilities, simple brick-making and pipe-making systems (for irrigation, waste disposal, etc.), the same kind of inexpensive conversion system that will turn cars and trucks into ambulances that was mentioned earlier: these are some of the needs. But there is much else: communication systems, simple educational devices, water filtration, and immunization and inoculation equipment need design or redesign.

With perfectly useful vehicles such as buses, railroad cars, trains, ferry boats, and steamers lying all over the place and not being used for anything, their redesign as movable classrooms, vocational re-educa-

tion centers, emergency hospitals, etc. seems warranted. Old ferry boats might ply some of the tributaries of the Amazon River, for instance, serving as clinics that provide birth control information, abortion counseling, X-rays, prescriptions for eyeglasses, dental care, and treatment for venereal diseases—just to give one possible example.

But most of the needs of the Third World will have to be solved there. Our responsibility as designers lies in seeing that emerging nations don't emulate our own mistakes of misusing design talent as an ego trip for the rich and a profit trip for industry.

At present we are told there is a world-wide food shortage. But the fact remains that there is plenty of food to go around. Food rots, is wasted, or is eaten by vermin. In most of the Third World all perishable food has to be eaten within 24 hours, or before it spoils. There simply are no vermin-proof cooling devices available. Industry (and designers) tend to shrug this problem off and, unconsciously paraphrasing a remark that triggered the first French Revolution, say: "Let them buy refrigerators!" Others become ensnarled in new technologies that *may* someday revolutionize methods of refrigeration.

At Cal Arts one of my graduate students, Jim Hennessey, and I were more concerned as to how Third World people could keep part of their perishables fresh for a week or two, starting *now*. We developed a hand-cranked, modular produce cooler. There is a baseboard unit that includes a tire pump, a heat exchanger, a pump, pump valves, and a metering valve, as well as a hand crank. This is surmounted by a 50 cm. styrofoam cube with a lid. It forces hot pressurized air through a heat exchange which returns the air to near-ambient temperature. The air is then metered back into the cooler, where, as it expands, it produces a temperature drop. Other modular cubes can be added. Certainly this is no way to keep two bottles of milk, some Coke, and a roast of beef freezing cold. But 20 minutes of cranking will ensure that, say, a

bushel of mangoes will be kept cool enough not to rot (40° F.) for 12 hours. More importantly, the units can be built on village levels in the Third World with existing tools and used valves. Since this problem was solved, we have begun doing research into substituting a sandwich panel (made of two outer layers of used newspapers and a core of dried native leaves) for the styrofoam. The design will be given to UNESCO.

At present no industrial design school is working with agricultural problems (irrigation, pest control, plowing, food storage, etc.). The few design offices that bother with them at all work on "sexier," "zippier" tractors or similar units for the front-lawn market.

There is so much else. American women seem to be willing to explore natural childbirth and Lamaze methods. Yet good graphic information (in the form of slides or simple schematic drawings) doesn't exist. The actual films of childbirth (natural or otherwise) usually induce only a swooning spell in husbands who watch them. Equally needed are simple, graphic, reassuring, non-verbal instructions about abortion.

In the field of transportation we may have to take a large step backward. I was lucky enough to be one of the few people who ever rode as a passenger in the *Graf Zeppelin*. It was both a luxurious and thoroughly delightful experience which colored all my childhood memories of travel. These giant dirigibles consisted of a large passengers' "gondola" which housed the captain's bridge, dining rooms, state rooms, and spacious corridors. The engines were housed in separate "nacelles" that, like the passengers' gondola, hung suspended from the gigantic aluminum structure. They were placed more than 100 feet aft of the passengers' cabins. Both vibration and engine noise were almost nil, and the dirigible, being lighter than air, needed only a slight push to go in the desired direction. Unlike today's jet, it did not rip through the air. In the late thirties, the zeppelins were phased out because of accidents involving the highly flammable

hydrogen used. But with our new technology, we may be able to bring them back; we now have gases that are less flammable or inert, thereby eliminating disaster. It would radically reduce pollution across the North Atlantic run, provide a safer and more comfortable trip, and merely add a few hours to the journey. It would be a perfect supplement to today's jets, and certainly a better solution than the criminal delinquency of the proposed SST. The lure of the SST lies in the simple fact that people desperately afraid of flying would like to reduce the duration of their death fear from 8 hours to 3. Dirigibles would give a safer and more comfortable alternative that is ecologically more responsible.

Always the alternative to being able to do things faster is to slow down. To bring back sailing ships for the North Atlantic run is perfectly feasible. The big hang-up with sailing ships was the manpower needed to work the rigging. Today all that could be automated. The second drawback to sailing ships was lack of speed. Today, as we can push people and goods across the ocean in a third of a day flying a jet, an alternate method seems possible here. I am delighted to find that both West Germany and the German Democratic Republic are developing such ships at this time.

While this list is far from complete, there are still a few items of high priority. Virtually nothing is specifically designed for left-handed people. Their problem is more complex than is commonly realized. While (of course) left-handed check books now exist, left-handed booklets of unemployment compensation and welfare forms do not. Some simple tools are bidextrous: a hammer or a screwdriver. To work a Nikon FTN camera, however (or most cameras), is nearly impossible. Some left-handed people are "right-eyed"; some have a predominating left eye. Steering mechanisms, knobs, and controls in most automobiles are designed for right-handed, right-eyed people.

Some tools designed even for the right-handed majority are also sadly lacking: take typewriters for

instance. The keyboard was designed so that the left hand, as well as certain fingers of the right hand, is forced into doing comparatively more work; finger-movement is often awkward. Nonetheless, keyboard organization remains "frozen."

Radical redesign of all sports equipment and especially competition sports equipment is needed. Much is unsafe, and almost everything is so expensive that it is plain why "low-income" people watch baseball on TV instead of going skiing or sailing. Much sports equipment is designed towards status-enhancement. Bad ski bindings on narrow Olympic cross-country skis crack tibias on the beginners' slopes. But beginners' bindings are few, and are merchandised inadequately and apologetically. The National Ski Patrol uses seven different ski rescue sleds. None of them are really safe.

If my sole intent were to make money, I would develop designs for some of these ideas rather than writing about them. As it is, I am developing designs in those areas that seem to me to have the greatest urgency. The rest are listed to provide turn-ons for others. My feelings about the basic wrongness of patents make this approach consistent and worthwhile.

This may be a good place to mention *Consumer Reports*. It attempts to evaluate products and rejects advertisements in order to operate more independently. The reports are usually intelligent appraisals of user considerations. But because the market is constantly flooded with new items, it is impossible for *Consumer Reports* ever to catch up. While health and safety hazards are pointed out, the magazine writes little about shoddy workmanship and *never* addresses itself to the triviality of an object per se. "Bottom-of-the-line" items, like Woolworth's 29¢ non-electric non-Teflon-coated, smallest frying pan, are almost never written about. Highly specialized pieces of equipment like certain photographic lenses, drafting tools, surveying instruments, medical tools, etc. suffer the same be-

nign neglect. (These same items are usually reviewed in professional magazines. According to a quick survey of some 60 products in 9 professional areas which I made recently, *everything is perfect!*) For how long consumers will submit to risk, harassment and empty promises is an open question, but one which the present depressed market may answer soon. *Consumer Reports,* never addressing itself to the "why" of an object, thus helps us choose the least among several evils.

Packaging can mask all kinds of mistakes, con games, or crimes. When evaluating the Campbell Soup Company's line of frozen breakfasts, Consumers Union, the non-profit group that publishes *Consumer Reports,* said that the food "smelled, felt, and tasted good" and went on to commend the "attractive" packaging. A little later they added that they had found rodent hairs and insect parts in the breakfast sausages. One of the most common packages that assaults us in supermarkets is that of breakfast cereal. Robert B. Choate, Jr., a former consultant on hunger to the Nixon Administration, demonstrated that Wheaties, "Breakfast of Champions," was 29th in nutritional value of 60 dry cereals tested. Nearly half of the cereals tested consisted of "empty calories" and had no nutritional value whatsoever.

Some months ago the British magazine *Design* poked fun at the designers by attributing to them an outlook of: "We are like Gods but we must not let anyone know." Considering all the areas which my list touches upon, it might be easy to assume that I feel that all the problems of the world can be solved through design. But in fact, all I am saying is that a great many problems could use the talents of designers. And this will mean a new role for designers, no longer as tools in the hands of industry but as advocates for users.

PART TWO

HOW IT COULD BE

7 REBEL WITH A CAUSE:
Creativity vs. Conformity

When you make a thing, a thing that is new,
it is so complicated making it
that it is bound to be ugly.
But those that make it after you,
they don't have to worry about making it.
And they can make it pretty, and so
everybody can like it
when the others make it after you.
—PICASSO (as quoted by Gertrude Stein)

It is the prime function of the designer to solve problems. My own view is that this means that the designer must also be more sensitive in realizing what problems exist. Frequently a designer will "discover" the existence of a problem that no one had suspected before, will define that problem and then attempt to solve it. This can be read as a definition of the creative process. Without doubt the number of problems that exist as well as their complexity have increased to such an extent that new and better solutions are needed.

At this point I should like to do a number of things: to attempt to describe the need for solving problems, to define that aspect of problem-solving behavior which has been called "creative," and to try to suggest methods for solving problems.

As both a designer and teacher, I am compelled to ask myself the question: "How can we make design better?" And the general consensus seems to be, both in schools and offices in this country and abroad, that the answer does *not* lie in teaching *more* design.

Rather, designers and students have to familiarize themselves with many other fields and, by knowing them, redefine the relevance of the designer to our society. The insights of the social sciences, biology, anthropology, politics, engineering, and technology, the behavioral sciences, and much else, must be brought to bear on the design process. Ways of doing this are suggested in great detail throughout this book. But the most important ability that a designer can bring to his work is the ability to recognize, isolate, define, and solve problems.

A little over a decade ago, the word "creativity" became a fashionable cliché for this activity. In fact, one California university is offering a course entitled "Remedial Creativity 201"!

How and why did being "creative" become a cliché? The ability to solve problems has been an inherent and desirable trait throughout human history. Mass production, mass advertising, the operation of the media, and automation are four contemporary trends that have emphasized conformity and made creativity a harder ideal to attain. In the twenties, Henry Ford, attempting to reduce the price of his cars through standardized production methods, is reputed to have said, "They [the consumers] can have any color they want as long as it's black." This implies that, through curtailing color differences, the price of individual automobiles will be lowered by some $95; conversely, consumers must be persuaded that black is a desirable color to have.

The spirit of conformity has accelerated at an amazing rate. The demands on the individual to conform come from all directions: not only do the national, state, and local governments enforce certain standards of behavior, but there are pressures from neighbors in suburban areas, conformist trends in school, at work, in church, and at play. What happens if we are unable to operate in so aggressively conformist an environment? We "blow our top" and are taken to the nearest psychiatrist for help. The first

thing this specialist in human thought and motivation may want to say to us (if not in so many words), is "Well, now, we must *adjust* you." And what is adjustment, if not another word for conformity? This is not to argue for a totally non-conformist world. In fact, conformity is a valuable human trait in that it helps to keep the entire social fabric together. But we have made our severest mistake in confusing *conformity in action* with *conformity in thought.*

Extensive psychological testing has shown that the mysterious quality called "creative imagination" seems to exist in all people but is severely diminished by the time an individual reaches the age of *six*. The environment of school ("You mustn't do this!" "You mustn't do that!" "You call that a drawing of your mother? Why, your mother only has *two* legs." "Nice girls don't do things like that!") sets up a whole screen of blocks in the mind of the child that later inhibits his ability to ideate freely. Of course, some of these prohibitions have social value: moralists tell us that they help the child establish a conscience; psychologists prefer to call this the formation of the superego; religious leaders call it "a sense of right and wrong," or "Soul."

However, society can go amazingly far in attempting to create greater conformity and protect itself from what the current mainstream of culture is pleased to call "deviants." In 1970 Dr. Arnold Hutschnecker suggested in a memo to President Nixon that all children between the age of six and eight be tested psychologically to determine if they *might* have the kind of tendencies that would turn them towards becoming criminals later in life. The underlying suggestion was that some of these children be tranquilized heavily and maintained in that condition, much as millions of elderly patients in retirement homes are kept under permanent doses of heavy tranquilizers in order to make the work of the nursing staff easier. Unfortunately, this proposal is characteristic of the kinds of pressures towards conformity that are often found in our institutions today.

Too many blocks can effectively stop problem-solving, and the wrong kind of problem statement can do the same. The old saying, "Build a better mousetrap and the world will beat a path to your door," is a case in point. What is the real problem here, to *catch* mice, or to *get rid of them?* Supposing my city is overrun by rodents. Suppose I *do* invent a better mousetrap. The result: next morning I will have 10 million captured mice and rats to contend with. My solution may have been highly innovative, but the original problem statement was wrong. The real problem was to *get rid* of the mice and rats. As a fantasized solution, it might have been better to broadcast an ultrasonic or subsonic beam over every radio and TV set for a few hours, which, while harmless to other living creatures, would sterilize all rats and mice. A few months later the rodent population would be gone. (This raises the ethical question as to whether rats and mice should be permitted to watch television.) More seriously, it would raise the environmental question to what extent some small rodents are important links in the eco-system.

However, most problems requiring immediate and radical new solutions lie in areas that are quite new.

Chad Oliver, in his science fiction novel *Shadows in the Sun*, says,

> . . . he had to figure it out for himself. That sounds easy enough, being one of the familiar figures of speech of the English language, but Paul Ellery knew that it was not so simple. Most people live and die without ever having to solve a totally new problem. Do you wonder how to make the bicycle stay up? Daddy will show you. Do you wonder how to put the plumbing in your new house? The plumber will show you. Would it be all right to pay a call on Mrs. Layne, after that scandal about the visiting football player? Well, call up the girls and talk it over. Should you serve grasshoppers at your next barbecue? Why, nobody does that. Shall you come home from the office, change into a light toga, and make

a small sacrifice in the backyard? What would the neighbors think?

But—how do you deal with a Whumpf in the butter? What do you do about Grlzeads on the stairs? How much should you pay for a new Lttang-nuf-fel? Is it okay to abnakave with a prwaatz?

Why, how silly! I never heard of such things. I have enough problems of my own without bothering my head with such goings on.

A Whumpf in the butter! I declare.

A situation completely outside human experience . . .

We live in a society that penalizes highly creative individuals for their non-conformist autonomy. This makes the teaching of problem-solving in design both discouraging and difficult. A twenty-two-year-old student arrives at school with massive blocks against new ways of thinking, engendered by some sixteen years of mis-education, a heritage of childhood and pubescence of being "molded," "adjusted," "shaped." Naturally, he will shop around for a school and study program which seems to hold out the greatest immediate personal rewards. Meanwhile our society continuously evolves new social patterns that promise a slight departure from the mainstream, but without ever endangering the crazy-quilt pattern of marginal groups that make up society as a whole.

First of all, we must understand the psychological aspects of problem-solving. While no psychologist or psychiatrist can as yet point to the exact mechanics of the creative process, more and more insights are becoming available. We know that the ability to generate new ideas freely is a function of the unconscious, and that it is the associative faculty of the brain that is at work here. The ability to come up with many new ideas is inherent in all of us, regardless of age (with the exception of senility and anility) or so-called IQ level (always excepting true morons).

In order to be able to associate freely, multi-disciplinary ability helps. The quantity of knowledge, the

quality of memory and recall can enrich this process. The ability to look at things in new ways is indispensable. This "new way of looking at things" can be enhanced through the knowledge and thorough understanding of a second language. For the structure of languages gives us ways of dealing with and experiencing realities, each discretely different in each language.

It is perfectly possible for instance to say, "I am going to San Francisco," in English. Verbally the same statement (*"Ich gehe nach San Francisco"*) is possible to frame in German, but it makes no sense whatsoever, linguistically. A qualifier must be added in German, for instance: I am *flying* to San Francisco, or I am *driving* to San Francisco. In Navaho and the Eskimo languages the statement must be even more specifically qualified to make sense: "I (alone, or with two friends, or whatever) am driving (sometimes I will drive, sometimes my friend will drive) (by cart, by sled) to San Francisco (then I will return and my friend will drive on)." By bringing more than one language to bear on a problem, we obtain more insight. Whether the language studied is German, Finnish, Swahili, Piano, Violin, Fortran, or Cobol matters little.

Intolerance creates more powerful blocks. Within the social scene, "tolerance" is imperative to the ability to solve problems. The folk-mind has anticipated the research findings of psychologists: "His mind is in a groove," or "He is in a real rut," are precise definitions of what really happens. If someone says "Black," "Jew," "Commie," "Hippie," "Catholic," or "hard hat," or what have you, and the immediate reaction is "son of a bitch," this has happened. The associational response of the brain has literally worn a groove (or rut) into the engram-response pattern of the cerebral cortex. Just as Pavlovian psychologists seem impelled by now to ring a bell every time a dog salivates, an intolerant person operates on a conditioned-reflex level.

Someone who routinely solves problems also re-

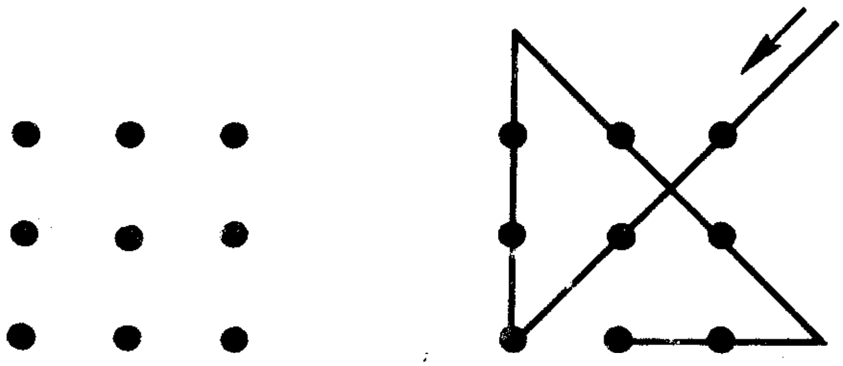
sponds to the concept "security" in a different way from that of his conformist contemporaries. In 1958 research conducted at U.C.L.A. among artists, architects, engineers with an unusually large number of patents, composers, musicians, writers, research scientists doing breakthrough work, has shown that one characteristic all of these people seem to have in common (regardless of their financial status) is that almost all of them are *under*-insured compared to standards set by the population at large. Creative individuals usually attempt to find security within themselves, rather than by paying $18.95 a month.

Until they enter school, most people seem to be about equally adept at solving problems. Then the inherent ability to create becomes inhibited by perceptual, cultural, associational, and emotional blocks.

Perceptual blocks are listed here only in order to point out their existence. A dichotomously color-blind person, for instance, has a slight perceptual block in the area of seeing. Trichotomous color-blindness constitutes a more serious block, whereas glaucoma, cataracts, and other phenomena leading to total blindness constitute total perceptual blocks to seeing. Deafness is a complete perceptual block to hearing. Often the psychological inability to use all the senses in observing data will lead to complete blocking. These perceptual blocks, if curable at all, are entirely in the province of the doctor, the surgeon, the psychiatrist.

Cultural blocks, as the name implies, are imposed upon an individual by his cultural surrounding. And in each society a number of taboos endanger independent thinking. The famous Eskimo nine-dot problem which can befuddle the average Westerner for hours on end is solved by Eskimo children within minutes because Eskimo space concepts are quite different from ours. Professor Edward Carpenter explains how the men of the Aklavik tribe in Alaska will draw reliable maps of small islands by waiting for night to close in, and then drawing the map by listening to the waves lapping at the island in the dark. In other

THE ESKIMO NINE DOT PROBLEM



The Problem: The Solution:

words, the island's shape is discerned by a sort of primitive radar. In Eskimo art we are sometimes confused, for we have lost the Eskimo's primitive ability to look at a drawing from all sides simultaneously.

Another problem of cultural blocking has been stated by a manufacturer of toilet bowls as follows: while the average American changes his automobile every 2½ years, gets a new suit about every 9 months, buys a refrigerator every 10 years, and even changes his residence about every 5 years, he never buys a new toilet bowl. If one could design the sort of bowl that would make people want to "trade in" their old one, this industry would benefit greatly. At first sight this seems to be a phony job, calling for artificially created obsolescence. And two answers to it immediately jump to the mind of the "stylist." The "Detroit approach": possibly providing the bowl with tailfins and vast chrome ornamentation. Another would be the "Toilet bowls are fun" approach: imprinting the surface with, say, little flowers, birds, or what have you. But intelligent research soon showed that *all toilet bowls are too high* (medically speaking). Ideally, people should assume a lower, squatting position when using this utensil. This can be achieved in two ways: by raising the floor or lowering the bowl. As the client was in the

Eskimo print:
"Spirits [*Tornags*]
Devouring Foxes."
Author's collection.

business of manufacturing toilet fixtures, a new lower bowl was designed and built for him. In spite of the obvious medical and sanitary advantages of this, in spite of the fact that now there existed a real reason for buying new toilet bowls, the design was rejected. The manufacturer felt that in this area the cultural block in the public mind was too great, and that it would be impossible for him to advertise his product. This is not an anecdote in somewhat poor taste, but rather an example of a very definite cultural block: the product could have been advertised easily in, say, Finland or Japan.

Cultural blocks operating in this area can be extremely counter-productive. On Earth Day, 1970, it was suggested that people might place 2 or 3 bricks in the water tanks of their toilets and thus cut down on the amount of water used each time. Here again I was able to suggest a redesign. Because what one does while sitting on a toilet differs in both quantity and quality, it seemed simple to redesign the apparatus so that one could select whether a great deal or only a minimal amount of water was needed for flushing. This concept again was rejected by my client—a man who makes his living manufacturing toilet bowls—as being "in bad taste."

Here again the temptation for the designer is just to go ahead and design a product such as the one outlined above, and in this way encourage consumerism. A better strategy is to give the public a series of comparable choices. In the above case this meant providing the redesigned water-saving toilet bowl for those consumers (such as construction firms, housing developers, etc.) about to buy one. At the same time an insert was designed that would have been marketed for under $10 to modify existing bowls to use less water. Finally, the option of just sticking 2 or 3 bricks in the water tank would still have been open to people so inclined.

The cultural taboo about elimination processes has made other developments difficult as well. Toilet tissue is made of paper so constituted that an enormously large quantity of water has to be used in its manufacture. For reasons now obscure to anyone, rolls of toilet paper are of a given width. By reducing this by one inch, millions of gallons of water would be saved daily in the manufacturing process, without cutting down on the function of the tissue itself. Yet here is another idea that is ecologically sound but has gone begging.

If I now try to escalate these examples from the disposal of fecal matter to its constructive use, still more people are turned off. Whenever the concept of recycling body wastes is brought up (for instance in a discussion of space capsules or space stations), people become disturbed. It is useful to remember that, on Liferaft Earth, everything we breathe, drink, eat, wear, or use has gone through billions of digestive systems since the planet was first formed. Our cultural blocks in this area tend to affect our thinking, our thinking affects our acts. We think of streams and lakes as "polluted by urban wastes," we use words like "sludge" and are appalled to find that our water sources are "poisoned" by human excrement. We are confused, as with the better mousetrap mentioned earlier, about whether we want to get rid of excrement or just separate it from our drinking supply.

I am suggesting that the entire field of *anaerobic and aerobic digestion* has been completely neglected. At the time of this writing (December 1970), only three major scientists are involved in studying the entire methane-generating process. Aside from occasional paragraphs in *The Whole Earth Catalog* about solitary British eccentrics who manage to power their automobiles from chicken droppings, the public is largely unaware of the gigantic energy sources that can be mined from our bodily processes of putrefaction, digestion, and waste-making. Yet the recycling of this energy, it seems to me, would be the first logical step in establishing a new life style.

It is well within the ability of contemporary research technology to develop a prime energy converter which, by using anaerobic digestion systems, would make a house truly independent of all external connections. In looking through the newspapers of communes and alternate societies, I have always thought it pathetic that much of their gear (transformers, pumps, high-fidelity components, light generators, projectors, etc.) still has to plug in somewhere. The use of biological recycling for energy would not only make true independence possible, but also bring about a breakthrough in ecology.

It is curious that virtually no research is going on in this area. It is unimportant whether the research is lacking because the field of study is simply too vast, or whether there is some gigantic conspiracy of power among oil companies to suppress such study. The point is rather that we are dealing with an area that the public has been taught to think of as "filthy," and hence, inquiry is aborted by a cultural block.

Much of this has already been tried, but usually just on an individual level. Dr. George W. Groth, Jr., maintains 1,000 hogs in confinement on his farm near San Diego, California. The hog manure operates a 10-kilowatt war-surplus generator, which provides all the electricity needed for both light and power. The liquid manure pit has been capped, and the sewer gas is tied to a gas engine. Hot water from the engine's

cooling system runs through 300 feet of copper tubing coiled inside the pit. A temperature of between 90° and 100° is maintained, which provides the best temperature for maximum "digestion." A tiny pump, running off the fan belt pulley, circulates the water. A complete digestion cycle takes about 20 days, but once the process is an on-going one, it is also continuous. Besides providing electric power, the system has virtually no odor, and attracts no flies. Finally, the manure at first breaks down into simple organic compounds like acids and alcohols. Ultimately, as there is no air, it breaks down into water, carbon dioxide, and methane gas.

Experiments of this sort have also been tried in Asia and Africa.

It seems clear that this design strategy can give us a way of using up human and animal waste by converting this material into power sources and recycling what is left. It is curious that what little has been written about it so far has appeared mostly in the underground press and alternative life-style papers.

Associational blocks operate in those areas where psychologically predetermined sets and inhibitions, often going back to our earliest childhood, keep us from thinking freely. An experiment, well known and several years old, will illustrate this point.

In one of our Eastern colleges a six-foot-long steel pipe with a diameter of 1½ inches was immovably fixed into the cement floor of a basement, so that one foot of the pipe was below floor level and 5 feet stuck straight up. A ping pong ball was then introduced into the pipe, so that it would rest at the bottom, 6 feet from the top opening. Placed in the room were a miscellaneous collection of tools, utensils, and gadgets. One thousand students were introduced into the room, one at a time, and asked to find some method for getting the ping pong ball out of the pipe. The attempts to solve the problem were as various as the students themselves: some tried to saw through the pipe, which proved too strong; others dripped steel filings onto the ping pong ball and then went "fishing" for it with a

magnet, finding that the magnet would adhere to the pipe wall long before it could be lowered all the way down. The attempt was made to raise it with a piece of chewing gum on a piece of string, but enough pendulum action was acquired in raising it so that the ball would inevitably drop off. To stick a series of soda straws together and try to "suck" it up also proved impossible. But sooner or later almost all of the students, 917 out of 1,000 (a respectable performance indeed) found a mop and a bucket of water in a corner, poured the water into the pipe, and floated the ball to the top. This, however, was only the control group.

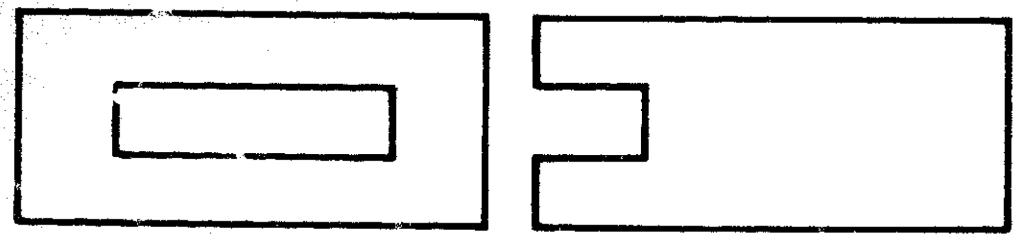
A second series of 1,000 students were then asked to solve the problem again; conditions remaining unchanged with one slight exception. The bucket of water was removed, and the psychologists substituted an antique rosewood table on which a finely cut crystal pitcher of water, two glasses, and a silver tray rested. Out of the second group only 188 solved the problem correctly. Why? Obviously because over 80 per cent in this group failed to "see" the water. The fact that a crystal pitcher standing on a rosewood table is more noticeable than a pail in a corner is obvious. What we mean to imply is that the second group failed to make the associational link between water and a flotation method. The associational gap was a much more difficult one to make with the handsome pitcher than with the pail, even though normally we are not given to pouring water out of a bucket to float ping pong balls either.

Shortly after the end of World War II, Raymond Loewy Associates designed a small home fan and succeeded in making the action truly noiseless. To their consternation, consumer response soon forced this design organization to introduce a new gear into the fan that would give off a slight sound, since the average American housewife associated noise with cooling action and felt that a totally noiseless fan did not provide enough cool air.

Sometimes, the specific training that people have

gone through professionally may establish even stronger associational blocks. When faced with the front elevation and the right side elevation of this object, and asked to draw a correct plan view or per-

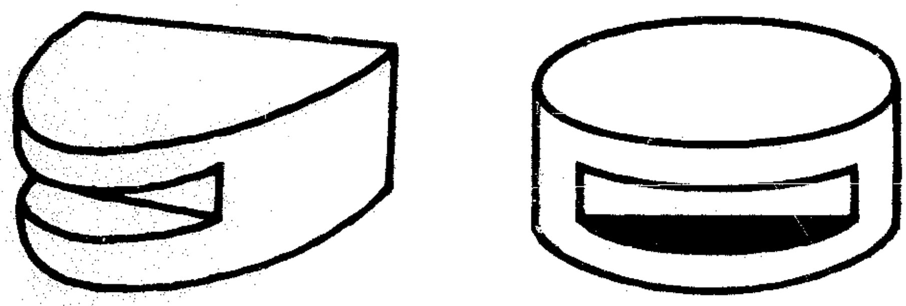
OBJECT VISUALIZATION PROBLEM



Front Elevation — Right Side Elevation

spective, architects, engineers, and draftsmen usually fail at a higher rate than that among people untutored in these fields. The correct answer to this particular problem is interesting for another reason as well. Two answers are equally correct, and, depending on which one is given, it becomes possible to see whether the student has arrived at a solution through a species of

OBJECT VISUALIZATION SOLUTIONS



Correct Solution: Deductive Reasoning — "Elegant" Correct Solution: Sudden Insight

creative analysis or "sudden insight." The reasoning behind giving answer number one runs somewhat as follows: "The right side elevation does not really work; it should be a center section. Therefore, since it would work perfectly as a center section, I must find a figure

where the theoretical center section and the right side elevation are identical. After selecting an equilateral triangle as the answer, I see that the front edge will show up as a line in the front elevation. By rounding this off, the line disappears and the problem is answered correctly." In the second case the equally right (but mathematically speaking much more "elegant") answer is arrived at through sudden insight and intuition.

Needless to say, the particular associational block that keeps people from answering this problem correctly, using either solution, lies in the fact that they set up a totally false, not specified, 90° angle relationship and therefore visualize the figure as being rectangular or square. "Rectangularity" or "squareness," then, is the basic block which the solver himself has built into the problem.

Emotional blocks may be the most difficult to overcome. The fear of making a mistake, the fear of making a fool of oneself, a pathological desire for security with an attendant unwillingness to gamble or pioneer, lack of drive to carry an idea through, because of the possibility of eventual failure—all these fall into this category. Other blocks in this area are a deep-seated feeling of inferiority in regard to creation—forcing the designer to "grab the first idea" instead of exploring several alternate solutions—fear of fellow designers, teachers, students, etc.

These points will recapitulate what has been established so far:

1 With constant pressure towards less individualism and greater conformity forced upon our society by mass advertising, mass media, mass production, and automation, the ability to solve problems in new and unexpected ways is becoming increasingly rare.

2 In a fast-accelerating, increasingly complex society, the designer is faced with more and more problems that can be solved only through new basic insights.

3 Design graduates leave our schools with some know-how, a great many skills, and a certain amount of aesthetic sensitivities, but with almost no method for obtaining any basic insights.

4 They find themselves unfit to solve new problems because of perceptual, cultural, associational, and emotional blocks. These blocks are the direct result of the constantly accelerating rat-race towards conformity and so-called "adjustment."

5 This race is not only inimical to all true design creativity but, in a wider sense, violates the very survival characteristics of the human species.

6 The various blocks are not inherited parts of the personality structure but rather learned, limiting, and inhibiting factors.

Our job then becomes one of establishing methods of doing away with these blocks. By repeatedly facing students and young designers with problems far enough removed from everyday reality so as to *force* them into entirely new thinking patterns, new cortical associations (both feet firmly planted on a pink cloud), by constantly pointing out to them the nature of the various blocks, it is possible to help them realize their creative design potential. By forcing them into solving problems that have never been solved before, lying outside of normal human experience, a habit pattern is slowly established, a habit pattern of solving problems without the interference of blocks (since, with problems removed from everyday experience, blocks cannot operate) and these habit patterns are then carried over into the solving of *all* problems, familiar or not.

What constitutes a "totally new problem, outside of all previous human experience"? If we are asked to design some fabulous animal unlike any we are familiar with, we will probably end up with something possessing the body of a horse, the legs of an elephant, the tail of a lion, the neck of a giraffe, the head of a stag, the wings of a bat, and the sting of a honeybee. In other words, we have really put a lot of familiar

things together in a totally unworkable, unfunctional, unfamiliar way. This is *not* solving a problem. If on the other hand, we are asked to design a bicycle for a man with three legs and no arms we can now solve a specific functional problem far enough removed from everyday previous experience to become valuable in this context.

The late Professor John Arnold, first at M.I.T. and later at Stanford, pioneered in this field with students in engineering and product design. Most famous of his problems is probably the "Arcturus IV" project: here the class is given voluminous reports regarding the inhabitants of the fourth planet in the Arcturus system, as well as the planet itself. An extraordinarily tall, slow-moving species descended from birds, these mythical inhabitants possess many interesting physiological characteristics. They are hatched from eggs, possessed of a beak, have bird-like, hollow bones, with three fingers on each hand and three eyes, the center one of which is an X-ray eye. Their reaction speed is almost ten times as slow as that of human beings, the atmosphere they breathe is pure methane. If a class is now asked to design, say, an automobile-like vehicle for these people, important and totally new limits within which to design are immediately established.

Obviously a gasoline gauge is unnecessary, since the Arcturians can always see through the gas tank with their X-ray eye. What about a speedometer? Obviously top speed will have to be in the neighborhood of 8 miles per hour since otherwise, with their slow reaction speed, the danger of crashing into another vehicle before being able to react is always present. Perceptually, however, such a people would experience the gradations of speed (up to 8 miles per hour) much as we experience the speed range in our own automobiles. The answer here then seems easy: subdivide a speedometer dial. But what kind of a numerical system would people use who have three fingers on each hand and three eyes: decimal, duodecimal, binary, sexagesimal? As these vehicles will be built on earth

and exported to Arcturus IV, should they use a standard gasoline engine shielded against the methane atmosphere, or must a new type of engine, specifically designed to operate optimally in methane, be designed? What of the overall shape of the vehicle? Should it be egg-shaped (a simple and sturdy form resolved when aerodynamics are of no importance), or would putting the Arcturians into an egg-shape become, psychologically speaking, a return to the womb, lulling them into a false feeling of security, and, therefore, be imposing the worst possible shape in terms of vehicular safety? Maybe our design consideration then becomes one of a shape as unlike an egg as possible—a difficult order to fill indeed!

Arcturus IV is just one of many problems evolved by Professor Arnold and, from the all-too-brief analysis of some of the possible approaches to it, it will be seen that, while fantastic and science-fictional in content, it is nonetheless a serious approach to creative problem-solving.

An even richer and more fertile area for problem statements can be derived from nature. In Chapter Five, I discuss the use of artificial seeds as part of a soil-erosion control device. In Chapter Nine, the flight and spiraling behavior of various seeds will be discussed in greater detail. For now it will suffice to state that a maple seed released in the air will at first plummet straight down for a foot or so, and then begin to drift gently and slowly down in a spiraling motion, finally coming easily to rest on the ground. (During the spiraling-down stage it is also affected by lateral wind drift.) Each student was given a maple seed and told to study it for two weeks. At the end of that period he was told to find a practical design application for it, utilizing both its general form (but not size) and its dynamics of downward motion.

Answers included a 54-inch sustained trouble flare for air-sea-rescue operations at night, devices to be dropped over northern Ontario for fish-stocking inaccessible lakes, reforestation capsules, devices for get-

ting food to snow-isolated cattle and wildlife. Other solutions included toys, a rotating lab for experiments in induced motion sickness and space medicine, high-altitude photo reconnaissance rockets in which the cameras form the pod component of a maple seed, and a plastic, chemical-filled maple seed, thousands of which would drift into and extinguish inaccessible spots in forest fires.

It can be seen from the foregoing that the "how" in teaching design creativity must consist largely of establishing a milieu in which new approaches can flourish. What has been the function of the school and education in general in this context? It has presented the cultural status quo of its time by dispersing whatever mass of data is currently acceptable as "truth." It has never concerned itself with the *individual* human brain; rather, the tremendous variation in human minds has been taken into account only as something to be flattened out so that the particular curriculum or theory in vogue at the moment can be "sold" with minimal effort. We have failed to recognize that discovery, invention, original thought are culture-smashing activities (remember $E = mc^2$?) whereas so-called education is a culture-preserving mechanism. By its very nature, education, as of now, cannot sponsor any vital new departures in any facet of our culture. It can only *appear to do so* to preserve the sustaining illusion of progress.

One of the major problems of successfully utilizing creative imagination is that "newness" often implies experiment, and experiment implies failure. In our success-oriented culture, the possibility of failure, although an unavoidable concomitant of experiment, works against the matrix. The creative designer, then, must be given not only the chance to experiment, but also the chance to fail. The history of all our progress is littered with a history of experimental failures. This "right to fail," however, does not absolve the designer from responsibility. Here, possibly, is the crux of the matter: to instill in the designer a willingness for ex-

perimentation, coupled with a sense of responsibility for his failures. Unfortunately, both a sense of responsibility and an atmosphere permissive to failure are rare indeed.

A more ideal creative-design environment will consist of habituating designers and students to work in areas where their many blocks and inhibitions cannot operate, and this will imply a high tolerance level for experimental failure. Furthermore, it must mean the teaching and exploring of basic principles which, by their very nature, have no immediate application. This calls for a "suspension of belief" in ready answers, and in the glib, slicked-up *Kitsch* that characterizes most of the design work coming out of schools and offices.

Unfortunately, our society is so structured that all of this is easily possible, paradoxical as this may sound. We need not journey to Arcturus IV to face designers and students with something completely outside their familiar experiences. All we have to do is to design for low-income families. For while designers have addressed themselves to the fads of the middle and upper bourgeoisie, it has also lately become fashionable to do a little bit of token designing for selected "house niggers" representing the poor. Meanwhile, we have lost sight of the fact that a very substantial part of our population is discriminated against in a more subtle fashion.

I am questioning, then, the entire currently popular direction of design. To "sex-up" objects (designers' jargon for making things more attractive to mythical consumers) makes no sense in a world in which basic need for design is very real. In an age that seems to be mastering aspects of form, a return to content is long overdue.

Much of what is suggested throughout this volume in the way of alternate areas for attack by designers also has the useful quality that it will be new to designers and students alike. If (within the meaning of this book) we do that which seems right, we will also develop our ability to see things in a new way and to do things that are new.

8 HOW TO SUCCEED IN DESIGN WITHOUT REALLY TRYING:

Areas of Attack for Responsible Design

One cannot build life from refrigerators, politics, credit statements, and crossword puzzles. That is impossible. Nor can one exist for any length of time without poetry, without color, without love.
—ANTOINE DE SAINT-EXUPÉRY

Industrial design differs from its sister arts of architecture and engineering. Where architects and engineers are hired to solve problems, industrial designers are often hired to create new ones. Once they have succeeded in building a new dissatisfaction into people's lives, they are then prepared to find a temporary solution for it.

The basic performance requirements in engineering have not really changed too much since the days of Archimedes: be it an automobile jack or a space station, it has to work, and work optimally at that. While the architect may use new methods, materials, and processes, the basic problems of human physique, circulation, planning, and scale are as true today as in the days of the Parthenon.

Industrial design, born at the beginning of the Great Depression, was at first quite properly a system that reduced manufacturing costs, made things easier to use, and improved the visual appearance of products along functional lines, to provide greater sale-

ability on the chaotic market place of the thirties. But as the industrial designer has gained power over the design of more and more products, as designers have begun to function as long-range planners on upper managerial levels, members of the profession have lost integrity and responsibility and become purveyors of trivia, the tawdry and shoddy, the inventors of toys for adults and poor toys for children.

As we move further into our age of mass production, design has become ubiquitous. All of our means of communication, transportation, consumer goods, military hardware, furniture, packages, medical equipment, tools, utensils, etc., are designed for us. With a present world-wide need of 472 million individual family living units, it can be safely predicted that even "housing," still built individually by hand, will become a fully industrially designed mass-produced consumer product within a decade.

What is the contemporary architect, if not a master assembler of elements? At his elbow is *Sweet's Catalogue*, the 26 bound volumes that list most building components, panels, mechanical equipment, etc., that occupies an honored place on the shelves of most architects' libraries. With its help, he fits together a puzzle called "house" or "school" or whatever, by plugging in components—designed, for the most part, by industrial designers and listed conveniently among the 10,000 entries in *Sweet's*. Where his predecessors might have used marble fasciae, he substitutes aluminum sandwich panels filled with polystyrene. (It is instructive to note that the handful of architects attempting to design and build in a Wrightian, original, and innovating manner, Bruce Goff, Paolo Soleri, Herb Greene, et al., have actually collectively built 0.3 houses annually.) Quite naturally some of the largest architectural offices, which have a budget permitting the use of a 1401–1410 computer set-up, merely feed all of *Sweet's* pages as well as the economic and environmental requirements of the job into the computer, and let the computer "design" the building. With en-

dearing candor, some architects have taken pains to explain that "the computer does an excellent job."

At other times, as in the case of the new TWA Terminal at Kennedy International Airport, the architect may create what is no more than a three-dimensional trademark, an advertisement through which people are fed, but whose function it is to "create a corporate image" for the client, rather than provide minimal comfort and facilities for passengers. Having been trapped at the TWA Terminal during a fifteen-hour power blackout, I can vouch for the inability of this sculptural "environment" to process men, food, water, waste, or luggage.

One of the difficulties with design-by-copying, design through eclecticism, is that the handbooks, the style manuals, and computer banks continuously obsolesce, go out of style, and become old-fashioned and irrelevant to the problem at hand. Furthermore, not only aesthetics is eliminated in designing via *Sweet's* and/or the computer: "The Concert Hall and the Moonshot Syndrome," by William Snaith in his *Irresponsible Arts*, gives an excellent example of this.

The lacy mantles and Gothic minarets of Edward Durell Stone and Yamasaki are little more than latter-day extensions of the Chicago Fair of 1893. Frothy trifles, concocted to re-inject neo-romanticism into our prefabricated, prechewed, and predigested cityscape, can nonetheless be unconsciously revealing. For who could see Yamasaki's soaring Gothic arches at the Seattle Science Pavilion without realizing that here science was at last elevated through glib design clichés to the stature of religion? One almost expected Dr. Edward Teller to appear one Sunday morn, arrayed in laboratory vestments, and solemnly intone: "$E = mc^2$."

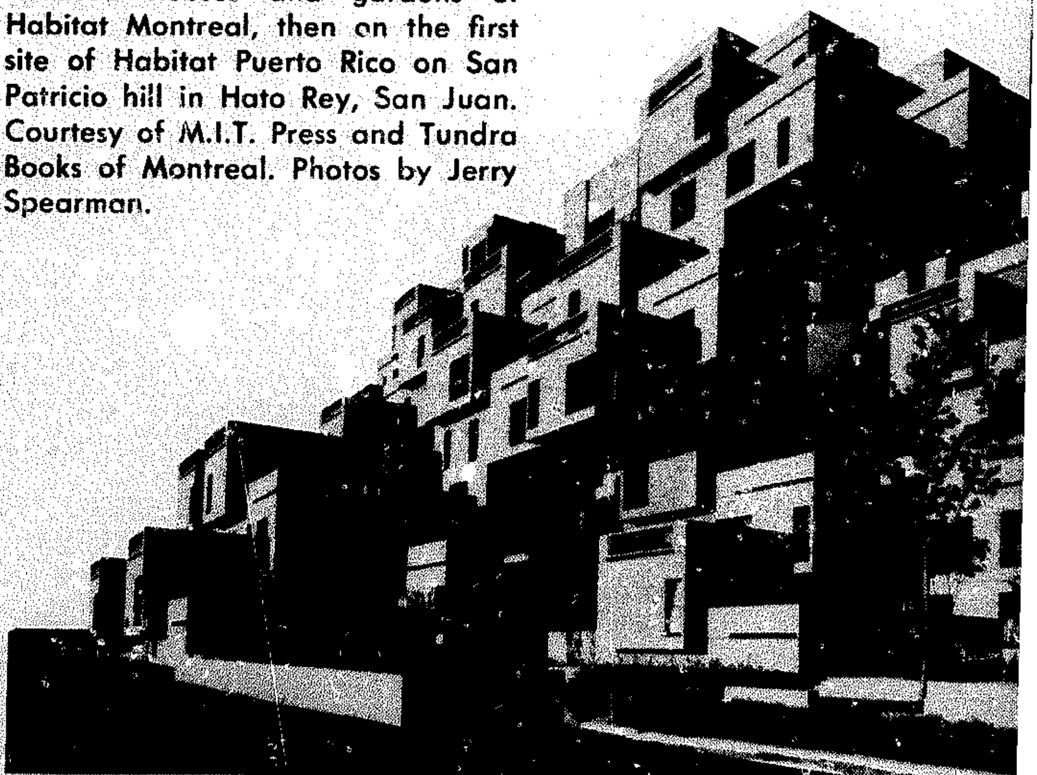
If the need for some 472 million housing units around the world is to be met, surely the answer lies in mass production techniques and totally new concepts. The architect as supreme master builder, or the architect who defiles this fair land with gigantic sterile file cabinets, ready to be occupied by interchangeable

people, or the speculative builder with his "boxes, little boxes" all are anachronisms in the seventies.

Buckminster Fuller, Jim Fitzgibbon of Synergetics, Inc., and a few other bold experimenters would shudder at the appellation "architect." But they are the type of designer whose comprehensive inventory of resources and needs in terms of global men, materials, tools, and processes will give us the industrially designed shelter of tomorrow.

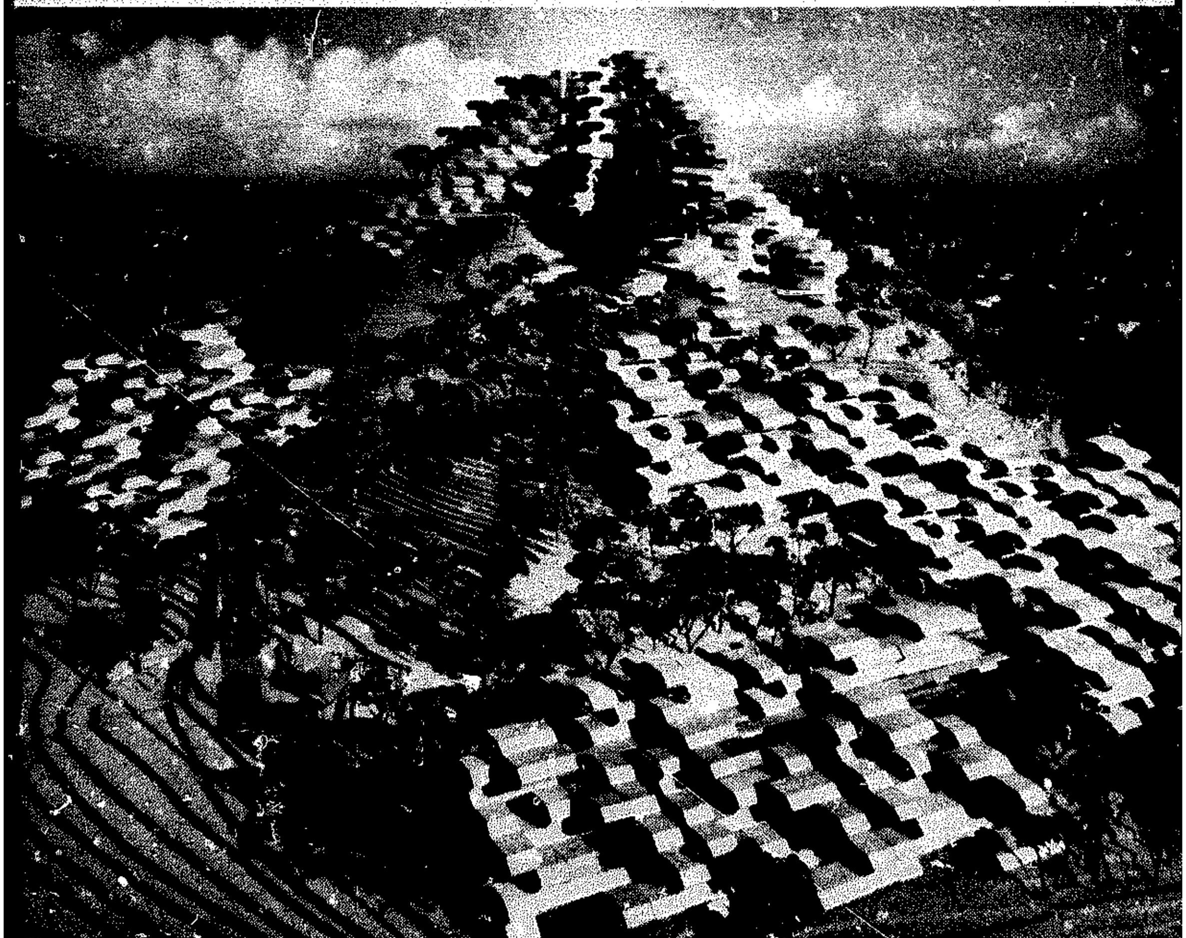
When Moshe Safdie designed and built Habitat, an example of a radically new type of shelter, for the Montreal Exposition of 1967, he was among the first architect-planners who attempted to use a modular building system intelligently. Habitat has often been faulted for being both too expensive and too complex. In reality Habitat is probably the least expensive and at the same time most varied *system* that can be de-

Modular Housing, shown first in the terraced houses and gardens of Habitat Montreal, then on the first site of Habitat Puerto Rico on San Patricio hill in Hato Rey, San Juan. Courtesy of M.I.T. Press and Tundra Books of Montreal. Photos by Jerry Spearman.



vised, and it is instructive to note that the Canadian Exposition Board made it impossible to build more than one third of the units. The strength of Habitat lies in the fact that once a large amount of money has been invested in basic building and handling equipment, the system then begins to pay for itself as more units are built. For a fuller understanding of the Habitat system, see Safdie's two newer projects in Puerto Rico and Israel (cf.: R. Buckminster Fuller's *Nine Chains to the Moon*, page 37, and Moshe Safdie's book, *Beyond Habitat*).

Hemlines go up and hemlines go down, the pneumatic sweater girl of the forties changed to the shaggy, bulky look of the fifties, only to be replaced by the glistening, jack-booted, vinyl-clad teeny-bopper of the sixties; and necklines, we are promised, will plunge



more deeply soon. Our young lady, window shopping in front of Paraphernalia, Inc., fully equipped with her "Frankly Fake Fur" miniskirt, electronic bra, black lace stockings and spike-heeled gold boots, has now finally emerged full-blown from the pages of Sacher-Masoch and Krafft-Ebing, read as arbiters of turned-on fashion. Men, gyrating from the "Bold" to the "Ivy-League" to the "Continental" to the "Carnaby Street" and later the "Virile" look, have also been at the mercy of fashion stylists. But here again, as in architecture, the industrial designer has entered the field of design for clothing through the back door, creating disposable work gloves (200 to a roll), ski boots, space suits, protective throw-away clothing for men handling radioactive isotopes, combat suits, and scuba gear. Lately, with the introduction of "breathing" and therefore really usable leather substitutes; much of the boot, belt, handbag, shoe, and luggage industry, too, is turning to the product designer for help. New techniques in vacuum forming, slush molding, gang turning, etc., make mass production design possible for products traditionally associated with handcrafted operations.

Thus tool, shelter, clothing, and breathable air and usable water are not only the job but also the responsibility of the industrial designer.

Mankind is unique among animals in its relationship to the environment. All other animals adapt themselves *autoplastically* to a changing environment (by growing thicker fur in the winter, or evolving into a totally new species over a half-million-year cycle); only mankind transforms earth itself to suit its needs and wants (*alloplastically*). This job of form-giving and reshaping has become the designer's responsibility. A hundred years ago, if a new chair, carriage, kettle, or a pair of shoes was needed, the consumer went to the craftsman, stated his wants, and the article was made for him. Today the myriad objects of daily use are mass-produced to a utilitarian and aesthetic standard often completely unrelated to the consumer's need. At this point Madison Avenue must be brought

in to make these objects desirable or even palatable to the mass consumer.

With products produced by the millions, mistakes too are multiplied a million times, and the smallest decision in design planning may have far-reaching consequences.

A simple example will suffice: Let's assume that the designers concerned with automotive styling in Detroit decide to move the car ashtray just 11 inches to the right, in order to establish greater "dashboard symmetry." And the results? *Twenty thousand Americans killed outright and another ninety thousand maimed on our highways within five years.* Almost an eighth of a million deaths and major accidents, caused by the driver being forced to reach just 11 inches further, thus diverting attention from the road for an extra 1/50 second. These figures are an extrapolation of the Vehicular Safety Study Program at Cornell University. It is interesting to note in this connection that, at the time of this writing, a General Motors executive has said that "GM bumpers offer one hundred per cent protection from all damage (and are therefore safe) *if the speed of the car does not exceed 2.8 mph*" (my italics). Meanwhile, the president of Toyota Motors is building a $445,000 shrine to "honor the souls of those killed in his cars." (Quoted in *Esquire* magazine, January 1972.)

Consider the home appliance field. Refrigerators are not designed, aesthetically or even physically, to fit in with the rest of the kitchen equipment. Rather, they are designed to stand out well against competing brands at the appliance store and scream for the consumer's attention.

Through wasting design talent on such trivia as mink-covered toilet seats, chrome-plated marmalade guards for toast, electronic fingernail-polish dryers, and baroque fly-swatters, a whole category of fetish objects for an abundant society has been created. I saw an advertisement extolling the virtues of diapers for parakeets. These delicate unmentionables (small,

Advertisement for diapers to be used for parakeets. Author's collection.

medium, large, and extra large) sell at $1 apiece. A long-distance call to the distributor provided me with the hair-raising information that 20,000 of these zany gadgets are sold each month.

In all things, it is appearance that counts, form rather than content. Let us go through the process of unwrapping a fountain pen we have just purchased as a gift. At first there is the bag provided by the store. Nestled in it is the package, cunningly wrapped in foil or heavily embossed paper. This has been tied with a fake velvet ribbon to which pre-tied bows are attached. The corners of the wrapping paper are secured with adhesive tape. Once we have removed this exterior wrapping, we come upon a simple gray cardboard box. Its only function is to protect the actual "presentation box" itself. The exterior of this little item is covered with a cheap leatherette that looks (somewhat) like Italian marble. Its shape conjures up the worst excesses of the Biedermeier style of

Viennese cabinetry during the last and decadent stages of that lamentably long period.

When opened, the vistas thus revealed would gladden the heart of Evelyn Waugh's *Loved One,* for they match the interior appointments of a Hollywood-created luxury coffin to a nicety. Under the overhanging (fake) silk lining, and resting on a cushion of (phony) velveteen, the fountain pen is at last revealed in all its phalliform beauty. But wait, we are not yet done. For the fountain pen itself is only a further packaging job. A recent confection of this type (selling for 75 bucks) had its outer casing made not of *mere* silver, but out of silver obtained by melting down ancient "pieces of eight" recovered, one must assume, at great expense from some Spanish galleon fortuitously sunk near the Parker Pen factory 3 centuries ago. A (facsimile) map giving the location of the sunken ship and tastefully printed on (fake) parchment, was enclosed with each pen.

However, whatever the material of the pen-casing, within it we find a polyethylene ink-cartridge (cost, including ink: 3¢) connected to a nib. Thus, more than 80 per cent of the material consists of packaging, totaling (minimally) 90 per cent of the cost.

This example could be easily duplicated in almost any other area of consumer goods: the packaging of perfumes, whiskey gift decanters, games, toys, sporting goods, and the like. Designers develop these trivia professionally and are proud of the equally professional awards they receive for the fruits of such dedicated labour. Industry uses such "creative packaging" —this, it is useful to note, is also the name of a magazine addressed to designers—in order to sell goods that may be shabby, worthless, or just low in cost, at grossly inflated prices to consumers.

In the case of the silver pen cited above, the retail price of the silver pen in its package is approximately 145,000 per cent higher than the cost of the basic writing tool. We may say that inexpensive pens are, after all, available, and that the example mentioned

merely illustrates "freedom of choice." But this "freedom of choice" is illusory, for the choice is open only to those to whom the difference between spending $75 or 19¢ is immaterial. In fact, a dangerous shift from primary use and need functions to associational areas has taken place here, since in most ways the 19¢ ball-point pen out-performs the $75 one. Additionally the tooling, advertising, marketing, and even the materials used in packaging represent such an exercise in futile waste-making that it cannot be countenanced in today's world. Well, what should package designers do?

As agricultural tools and implements, building components, and the like are shipped to the Third World, another need emerges in the field of package design: a way of imposing sequentially hierarchic assembly procedures on illiterate people, through the way in which the package surrounding the parts opens or unfolds. Anyone who has seen the huts hammered together out of flattened oil tins that provide shelter for millions of people throughout South America and South Africa must have asked himself why oil (and other raw materials) is not shipped in containers more suitable as building components. Re-use and different-use packaging is another major design challenge (for those package designers who feel like participating in rational work).

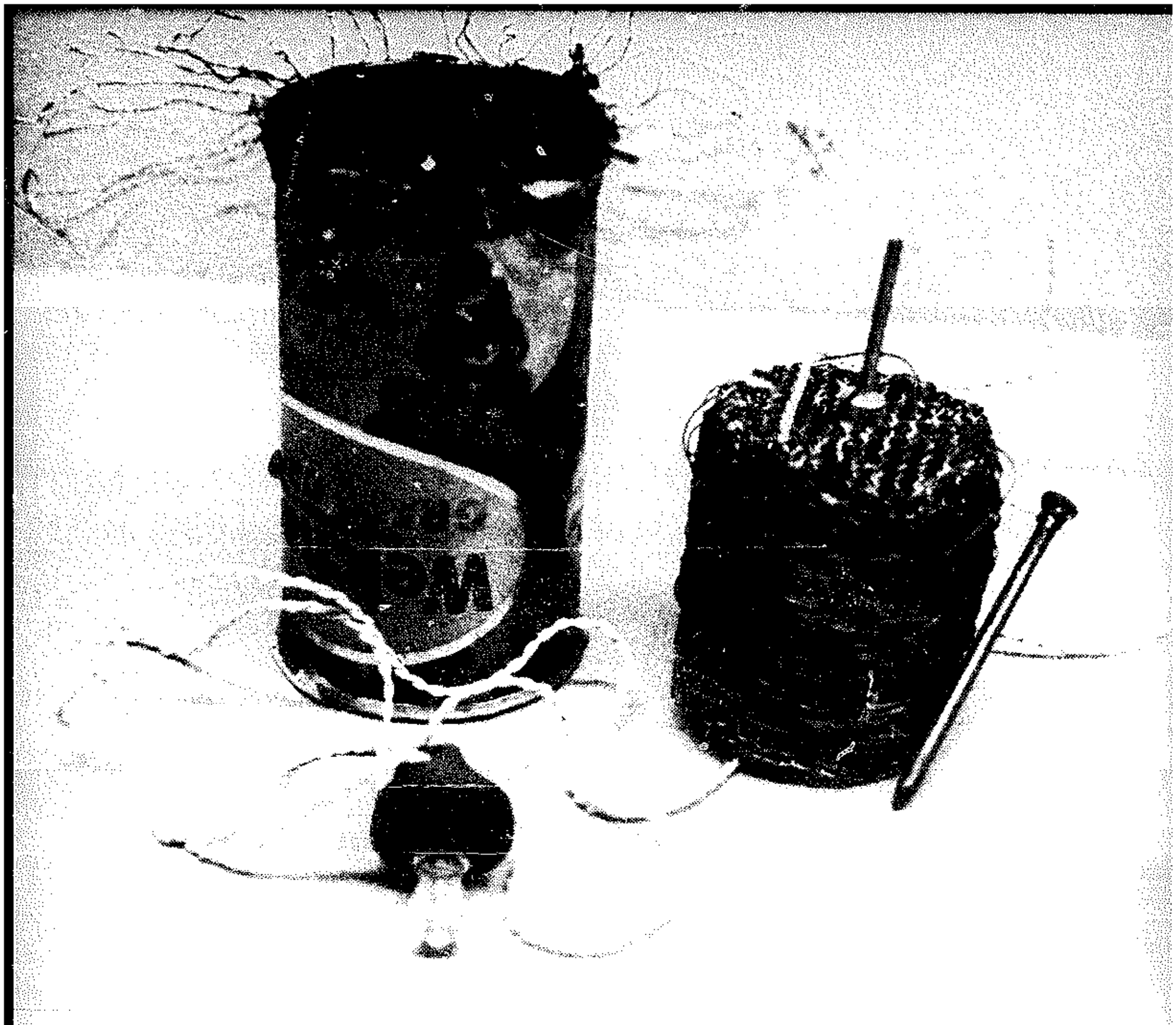
When we say that "the people's basic needs are satisfied," we are taking a narrow and parochial view. Right in our own country we are neglecting the needs of vast land-poor farm country, the multi-racial ghettos in our cities, the hard-core poor, and the mentally and physically retarded and disadvantaged. We also deliberately exclude 2,350,000,000 human beings in the so-called underdeveloped areas of the world. While it is true that the governments of the emerging nations of Africa, Asia, and the Americas are often engaged in the same frenzied, fetishistic rat-race to gain status symbols as nations as Americans are as individuals, the real needs of the broad masses of people remain unsatisfied. Substituting a national airline for our fam-

ily Cadillac; building a cyclotron as we might build a family recreation room; installing a country-wide superhighway (with few cars and no service stations) as we might install air-conditioning; or using World Bank loans much as we might flash our charge-a-plates or Playboy keys: these examples of governmental status-seeking suffice.

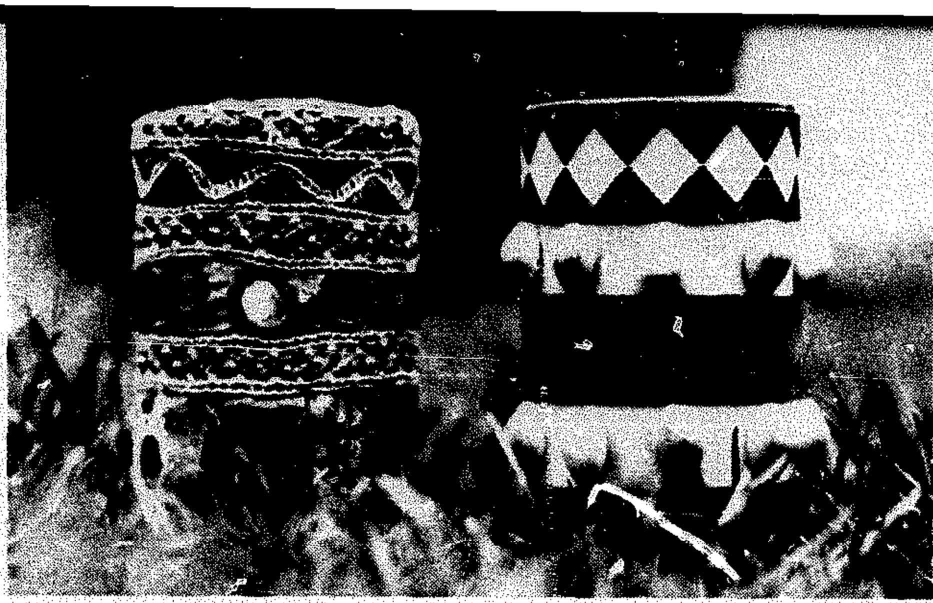
Only a handful of American corporations and design offices are seriously engaged in facing up to challenges such as global minimal shelter needs, off-road vehicles for roadless terrain (84 per cent of the earth's land surface has no roads), new and compact teaching and training equipment geared to a society changing from a pre-literate one to a post-literate electronic one, and all on 1 HP per capita. The list is endless: power sources, basic medical, surgical and sanitation devices, food storage, communications, etc.

Several years ago I was approached by representatives of the United States Army and told of their practical problems concerning parts of the world (like India) where entire populations are illiterate and living on extremely low power levels. In many cases this means that the largest percentage of the population are unaware of even so basic a fact as their living in India. As they cannot read, and as there is neither enough power for radios, nor money for batteries, they are effectively cut off from all news and communication. I designed and developed a new type of communications device.

An unusually gifted graduating student, George Seegers, did all the electronic work and built the first prototype. It is a one-transistor radio, using no batteries or current, and designed specifically for the needs of developing countries. The unit consists of a used tin can. (As illustrated in this book, a used juice can is shown, but this is no master plan to dump American "junk" abroad: there is an abundance of used cans all over the world.) This can contains wax and a wick which will burn (just like a wind-protected candle) for about 24 hours. The rising heat is con-



verted into enough energy (via a thermocouple) to operate an ear-plug speaker. The radio is, of course, non-directional. This means that it receives all stations simultaneously. But in emerging countries, this is of no importance: only one broadcast (carried by relay towers placed about 50 miles apart) is carried. Assuming that one person in each village listens to a "national news broadcast" for 5 minutes daily, the unit can be used for almost a year until the original paraffin wax is used up. At that time more wax, wood, paper, dried cow dung (which has been successfully used as a heat source for centuries in Asia, but for that matter anything else that burns will also work) will continue the unit in service. All the components: ear-plug speaker, hand-woven copper radial antenna, a "ground" wire terminating in a (used) nail, tunnel-



Radio receiver designed for the Third World. It is made of a *used juice can, and uses paraffin wax and a wick as power* source. The rising heat is converted into enough energy to power this non-selective receiver. Once the wax is gone, it can be replaced by more wax, paper, dried cow dung, or anything else that will burn. Manufacturing costs, on a cottage industry basis: 9 cents. Designed by Victor Papanek and George Seeger at North Carolina State College.
The same radio as on left, but decorated with colored felt cutouts and sea shells by a user in Indonesia. The user can embellish the tin can radio to his own taste (Courtesy: UNESCO).

diode, thermocouple, etc., are packed in the empty upper third of the can. The entire unit can be made for just below 9¢ (U.S.).

It is, of course, much more than a "clever little gadget." It is a fundamental communications device for pre-literate areas of the world. After it was tested successfully in the mountains of North Carolina (an area where only *one* broadcast is easily received), the device was demonstrated to the Army. They were shocked. "What if a Communist," they asked, "gets to the microphone?" The question is meaningless, since the most important business before us is to make information of all kinds freely accessible to the people. After further developmental work, I gave the radio to UNESCO. UNESCO in turn is seeing to it that it is distributed to villages in Indonesia. No one, neither

the designer, nor UNESCO, nor any manufacturer, makes any profit or percentages out of this device since it is manufactured as a "cottage industry" product.

In 1966 I showed color slides of the radio at the *Hochschule für Gestaltung,* at Ulm in Germany. It was interesting to me that nearly all the professors walked out (in protest against the radio's "ugliness" and its lack of "formal" design), *but all the students stayed.* Of course, the radio *is* ugly. But there is a reason for this ugliness. It would have been simple to paint it ("gray," as the people at Ulm suggested). But painting it would have been wrong. For one thing, it would have raised the price of each unit by maybe one twentieth of a penny each, which is a great deal of money when millions of radios are built. Secondly, and much more importantly, I feel that I have no right to make aesthetic or "good taste" decisions that will affect millions of people in Indonesia, who are members of a different culture.

The people in Indonesia have taken to decorating their tin can radios by pasting pieces of colored felt or paper, pieces of glass, and shells on the outside and making patterns of small holes toward the upper edge of the can. In this way it has been possible to by-pass "good taste," design directly for the needs of the people, and "build in" a chance for the people to make the design truly their own.

This is a new way of making design both more participatory and more responsive to people in the Third World.

It is true that during the fifties some large design offices, such as Chapman & Yamasaki of Chicago, Joe Carreiro of Philadelphia, and others, performed design development work in underdeveloped countries at the request of the State Department. But their work was largely in the area of helping young nations to design and manufacture objects that would appeal to the American consumer. In other words, they did not design for the needs of the people of Israel, Ecuador, Turkey, Mexico, etc., but rather for the fancied wants of American purchasers.

Our landscape as well bears the stamp of irresponsible design. Look through the train window as you approach New York, Chicago, Detroit, Los Angeles. Observe the miles of anonymous tenements, the dingy, twisted streets full of cooped-up, unhappy children. Pick your way carefully through the filth and litter that mark our downtowns or walk past the monotonous ranch houses of suburbia where myriad picture windows grin their empty invitation, their televiscous promise. Breathe the cancer-inducing exhaust of factory and car, watch the strontium-90 enriched snow, listen to the idiot roar of the subway, the squealing brakes. And in the ghastly glare of the neon signs, under the spiky TV aerials, remember, this is our custom-designed environment.

How has the profession responded to this situation? Designers wield power over all this, power to change, modify, eliminate, or evolve totally new patterns. Have we educated our clients, our sales force, the public? Have designers attempted to stand for integrity and a better way? Have we tried to push massively forward, not only in the market place but in the affections of needy people of the world?

Listen in on a few imaginary conversations in our design offices:

"Boy, wrap another two inches of chrome around that rear fender!"

"Somehow, Charlie, the No. 6ps red seems to communicate freshness of tobacco more directly."

"Let's call it the 'Conquistador' and give people a chance for personal identification with the sabrematic shift control!"

"Jesus, Harry, if we can just get them to PRINT *the instant coffee right onto the paper cup, all they'll need is hot water!"*

"Say, how about roll-on cheese?"

"Squeeze-bottle martinis?"

"Do-it-yourself shish-kebab kits, with disposable phenolic swords?"

"Charge-a-plate divorces."

"An aluminum coffin, communicating 'nearness-to-God' (non-denominational) through a two-toned anodized finish?"

"A line of life-sized polyethylene Lolitas in a range of four skin shades and six hair colors?"

"Remember, Bill, the corporate image should reflect that our H-bombs are always PROTECTIVE!"

These imaginary conversations are quite authentic: this is the way designers talk in many offices and schools, and this is also the way in which new products often originate. I might add that industrial designers actually enjoy reading such dialogues. One proof of this authenticity is that, of the eleven idiocies listed above, all but two—charge-a-plate divorces and "protective" H-bombs—are now on the market.

You may wonder if this isn't just a hysterical outburst, directed towards some of the phonier aspects of the profession? Are there no dedicated designers working away at jobs that are socially constructive? The truth is that, of all the articles in the professional magazines, of all the talks at design conferences, few indeed have dealt with professional responsibilities, responsibility going beyond immediate market need. The latter-day witch doctors of market analysis, motivation research, and subliminal advertising have made dedication to meaningful problem-solving rare and difficult.

The philosophy of most industrial designers today is based on five myths. By examining these, we may come to understand the *real* underlying problems:

1 *The Myth of Mass Production:* In 1966, 16 million easy chairs were produced in the United States. But if we divide this number by the 2,000 manufacturers of such chairs we find that, averaging it out, only 8,000 chairs could have been produced by each manufacturer. If we further realize that each manufacturer has, on the average, 10 different models in his line, this reduces our number to only 800 chairs of one kind. If we now add the fact that furni-

ture manufacturers' lines change twice a year, in time for the spring and fall market showings, we will find that, on the average, only 400 units of any given chair were produced. This means that the designer, far from working for 200 million people (the market he is trained to think about) has, on the average, worked for 1/5,000th of 1 per cent of the population. Let's contrast this with the fact that in backward and underdeveloped areas of the world there exists a present need for close to 2 billion inexpensive, basic seating units.

2 *The Myth of Obsolescence:* Ever since the end of World War II, an increasing number of responsible people in the very top levels of management and government have voiced the myth that, by designing things to wear out and be thrown away, the wheels of our economy can be kept turning *ad infinitum* and *ad nauseam*. This is patent nonsense. One of the healthiest companies in the United States is the Polaroid Corporation. Even though new models of Polaroid Land cameras have replaced earlier models over the years, none of the old cameras are obsolete because the corporation is careful to continue manufacturing film and accessories for them. The German Volkswagen has moved into a leading position in supplying the transporation needs of the world by carefully refraining from major style changes or cosmetic jobs. The Zippo cigarette lighter sells at a far better rate than all other domestic lighters combined, even though (or could it be because?) the manufacturer guarantees to repair or replace its case and/or guts for life. (In fact, it is outsold only by foreign, point-for-point copies.) There is ironic justice in that. For it was in 1931 that George Grant Blaisdell, a non-smoking American, noticed that some of his friends carried wind-proof, dependable, Austrian cigarette lighters which sold in chain stores for twelve cents. He tried importing them directly and selling them at $1 apiece, but finding that the public was unwilling to pay that much during the Depression, he quit temporarily. He waited for the patent of the

Austrian model to expire and began producing it in 1935 and offering it for sale with a life-time guarantee. The Zippo lighter has moved from an item made on $260 worth of second-hand tools, in a $10 room in Brooklyn, to a production level of 3 million units per year. Since many of our products are beginning to be obsolesced technologically anyhow, the question of forced obsolescence becomes redundant and, in terms of raw materials, a dangerous doctrine indeed.

3 *The Myth of the People's "Wants":* Never in recent times have the so-called "wants" of people been investigated as thoroughly by psychiatrists, psychologists, motivation researchers, social scientists, and other miscellaneous tame experts, as in the case of the ill-fated "Edsel." That mistake cost $350 million and led one comedian to quip that the mistake "was being handled by the Ford Foundation."

"The people want chrome, they like tailfins," except the Volkswagen and the Fiat exploded that idea thoroughly. So thoroughly, in fact, that Detroit had to start producing compact cars a few years ago when foreign imports began to seriously affect American sales figures. As soon as foreign imports began to drop off, compact cars were again advertised as "the biggest, longest, lowest, most luxurious of them all." This stylistic extravaganza has now once more raised the number of small European cars coming into the country.

4 *The Myth of the Designer's Lack of Control:* We are told that it is "all the fault of the front office, the sales department, market research," etc. But of 150 mail-order, impulse-buying items foisted on the public during the last few years, a significantly large number were first conceived, invented, planned, patented, and produced by members of the design profession. These products include such inspiring items as:

A comparison of Automobiles of 1949. Advertisement by Volkswagen of America, Inc.

"Mink-Fer," a tube of deodorized mink dropping sold at $1.95 each as a Christmas fertilizer for "the plant that has everything."

A $1,595 electronic computer for practicing golf swings. This tidy item makes it possible to play golf in the bathroom or cellar without ever having to go outdoors at all.

A $39.95 electronic clip-on gadget that attaches to the front of the automobile and flashes the message "You're welcome!" when the electronic traffic light in a pay-it-yourself highway toll booth lights up to say "Thank you."

5 *The Myth That "Quality No Longer Counts":* While Americans have for years bought German, and later, Japanese cameras, Europeans now line up to buy Polaroid Land cameras and equipment. American "Head" skis are outselling Scandinavian, Swiss, Austrian, and German skis around the world. Sales of Schlumbohm's Chemex coffee maker are diminished only somewhat by a recent German copy of it. The United States Army Universal Jeep designed by Willys in 1943 (since modified, and sold by American Motors) is still one of the most desirable multi-purpose vehicles on earth; its only major foreign competitors are the British Land Rover and the Japanese Toyota Land Cruiser, both updated and improved versions of the Jeep.

The one thing which these and some other American products that still command world leadership hold in common is a basically new approach to a problem, excellent design, and the highest possible quality.

Something can be learned from these five myths. It is a fact that the designer often has greater control over his work than he believes he does, that quality, basic new concepts, and mass production could mean designing for the majority of the world's people, rather than for a small domestic market. Designing for the people's *needs* rather than for their *wants*, or artifici-

ally created wants, is the only meaningful direction now.

Having isolated some of the problems, we must ask what can be done about them. At present there are several fields in which little or no design work is being done. These are areas that are, by their very nature, highly profitable to manufacturer and designer alike. They are areas that promote the social good that can be inherent in design. All that is needed is a selling job, and that is nothing new to the industrial design profession.

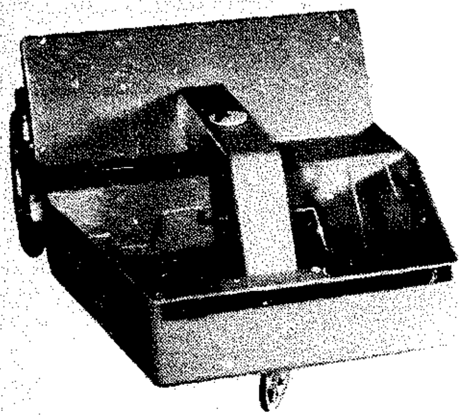
It is possible to outline briefly a number of important areas in which the discipline of industrial design is virtually unknown:

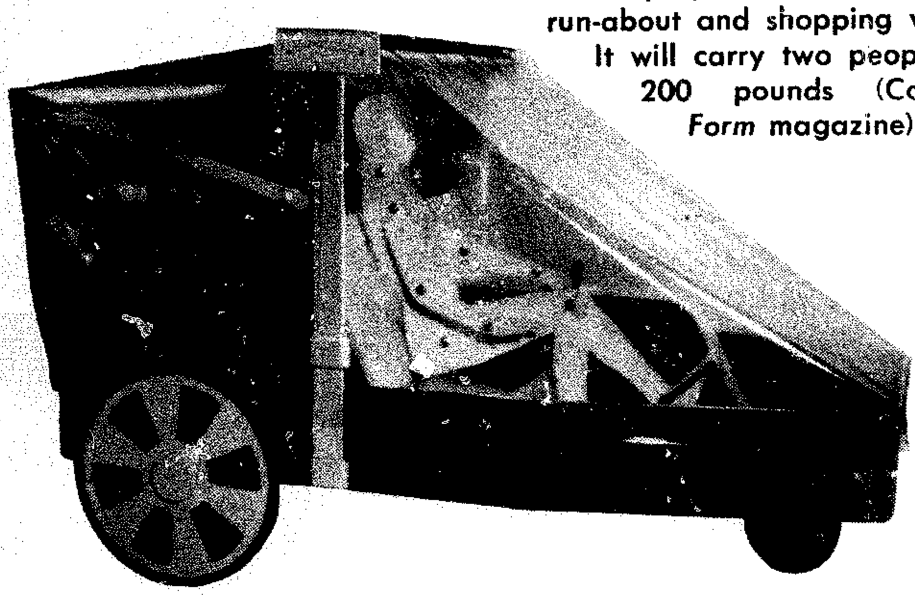
1 *Design for Underdeveloped Areas:* Over two billion people stand in need of some of the most basic tools and implements.

Today more oil lamps and other kinds are needed globally than before the discovery of electricity because there are more people without electric power alive today than the entire global population in Thomas Edison's day. In spite of new techniques, materials, and processes, no radically new oil lamp (or for that matter, primitive light source) has been developed for 106 years.

Eighty-four per cent of the world's land surface is completely roadless terrain. Often epidemics sweep through an area: nurses, doctors, and medicine may be only 100 kilometers away, but there is no way of getting through. Regional disasters, starvation, and water shortages also develop frequently: again there seems to be no good way of getting through. Helicopters work, but are far beyond the monies and expertise available in many regions of the Third World. Beginning in 1962, a graduate class and I developed an off-road vehicle that might be useful for such emergencies. We asked that it fulfill the following performance characteristics:

a The vehicle would operate on ice, snow, mud,





Mock-ups and working models of two vehicles designed and built under the author's direction at Konstfackskolan in Stockholm, Sweden. These vehicles were explorations in transporting materials over rough terrain by muscle power alone. One of them (designed by James Hennessey and Tillman Fuchs) is a proposal for an inner-city run-about and shopping vehicle. It will carry two people and 200 pounds (Courtesy: *Form* magazine).

montane forests, broken terrain, sand, certain kinds of quicksand, swamps, etc.

b The vehicle would cross lakes, streams, and small rivers.

c It would climb 45° inclines and transverse 40° inclines.

d It would carry a driver and 6 people, or a driver and a 1,000-pound load, or a driver and 4 stretcher cases; finally it would be possible for the driver to walk next to the vehicle, steering it with an external tiller, and thus carry more load.

e The vehicle could also remain stationary and, with a rear-power takeoff, drill for water, drill for oil, irrigate the land, fell trees, or work simple lathes, saws, and other power tools.

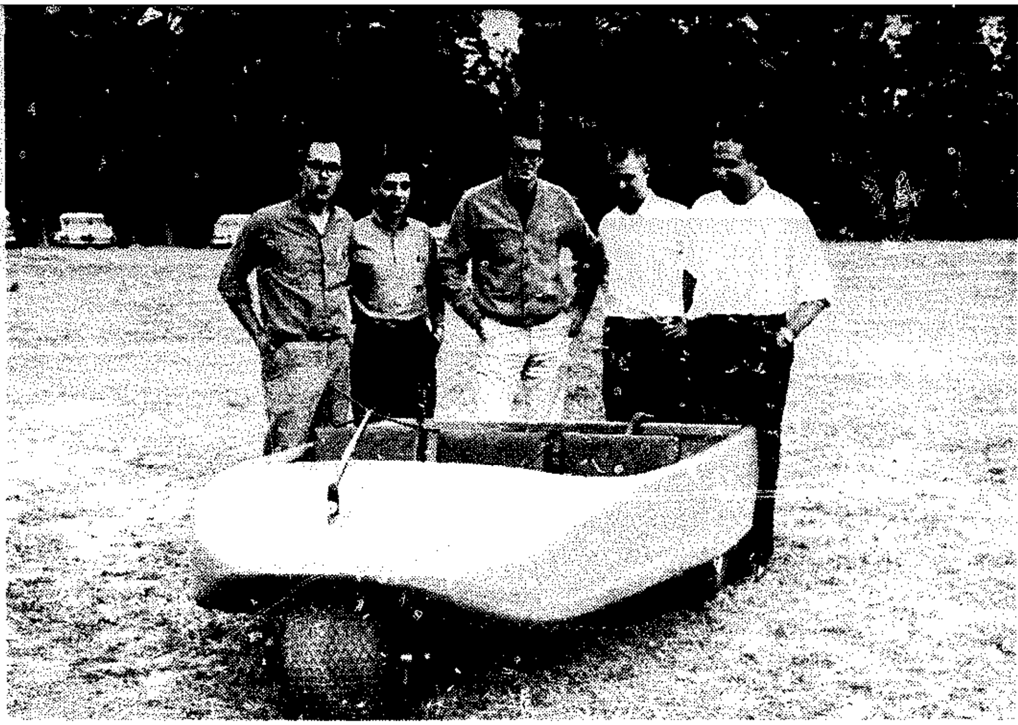
By inventing and testing a completely new ma-

terial, "Fibergrass" (*sic*)—using conventional chemical fiberglass catalysts, but substituting dried native grasses, hand-aligned, for the expensive fiberglass mats—we were able to reduce costs. Over 150 species of native grasses from all parts of the world were tested. By also attacking the manufacturing logistics, it was possible to reduce costs still more. Various technocratic centers were established: heavy metal work was to be done in the United Arab Republic, Katanga, Bangalore (India), and Brazil. Electronic ignitions were to be made in Israel, Japan, Puerto Rico, and Liberia. Precision metal work and the power train were to be done in the Republic of China, Indonesia, Ecuador, and Zambia. The Fibergrass body would be made by users all over the world. Several prototypes were built, and it was possible to offer the vehicle to UNESCO at a unit price of less than $150.

But this is where responsible design must begin to operate. The vehicle worked fine, and in fact, UNESCO told us that close to 10 million vehicles might be needed initially. But the net result of going ahead with this would have meant introducing 10 million internal combustion engines (and consequently, pollution) into hitherto undefiled areas of the world. So we have shelved the off-road vehicle project until a better power source is available.

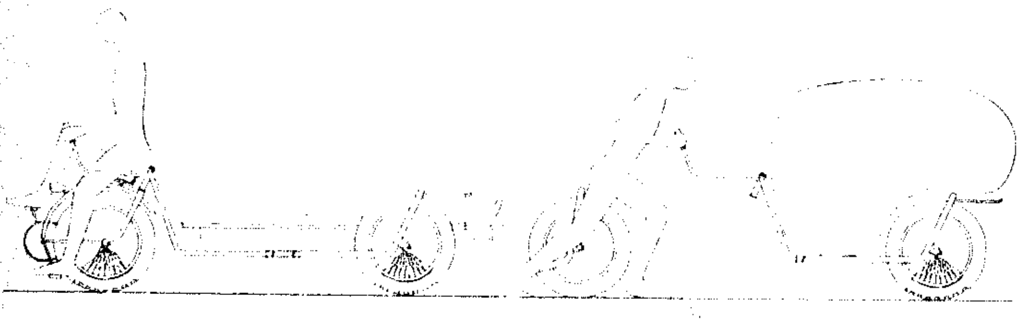
(Historical footnote: as I do not believe in patents, photographs of our vehicle were published in a 1964 issue of *Industrial Design* magazine. Since then, more than 25 brands of vehicles, priced between $1,200 and $2,000, have been offered to wealthy sportsmen, fishermen, and (as "fun vehicles") to the youth culture. These vehicles pollute, destroy, and create incredible noise problems in wilderness areas. The destructive ecological impact of the "snowmobile" is detailed in Chapter Ten.)

At this point, as a result of our concern for pollution and together with a group of Swedish students at *Konstfackskolan* in Stockholm, we began exploring muscle-powered vehicles. The Republic of North Vietnam moves 500-kilogram loads into the southern



Off-Road Vehicle, discontinued for ecological reasons, designed by student team under the author's direction, School of Design, North Carolina State College, 1964.

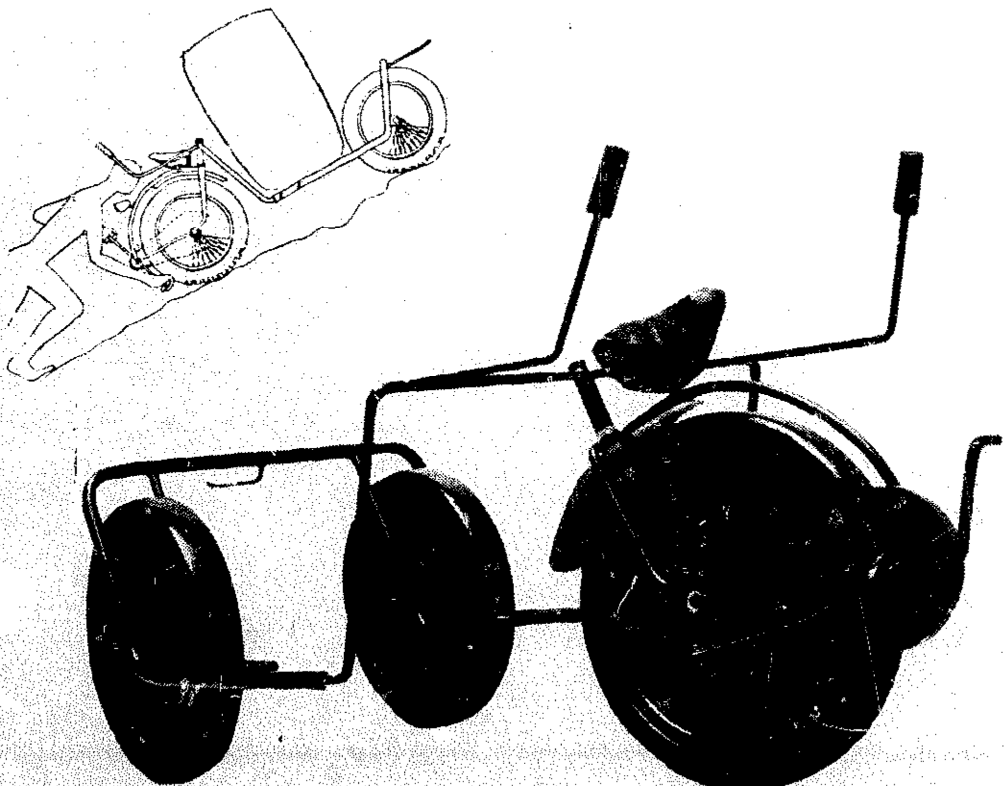
part of that country by pushing these loads along the Ho Chi Minh trail on bicycles. The system works and is effective. However, bicycles were never de-

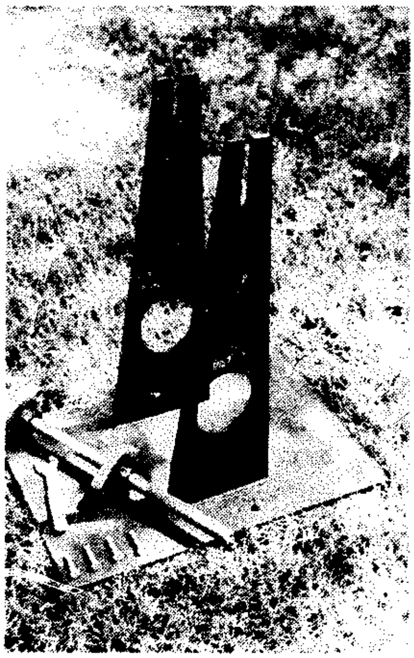


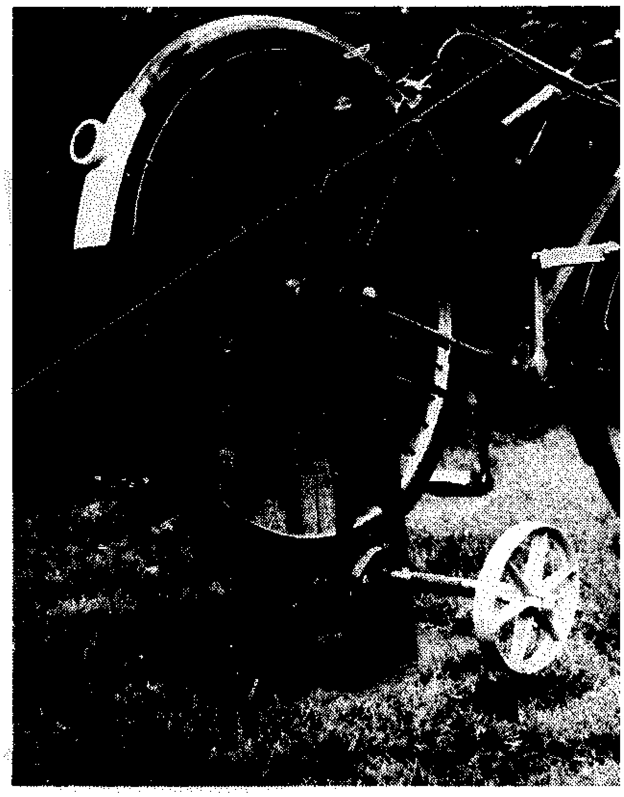
These drawings show that the muscle-powered vehicle can be plugged together into a short train. It also comes apart, and the geared power pod is reversible so that the vehicle can be pushed uphill under heavy loads. It can also carry stretchers or with the power pod removed, be used like a wheelbarrow. Designed under the author's direction by a student team in Sweden, it could be used in underdeveloped areas to propel heavy loads, similar to the loads pushed on bicycles along the Ho Chi Minh Trail in North Vietnam. (Photos by Reijo Rüster. Courtesy *Form* magazine.)

signed to be used in just this manner. One of our student teams was able to design a new type of vehicle, made of bicycle parts, that would be more effective. The new vehicle is specifically designed for pushing heavy loads; it is also designed to be pushed easily uphill through the use of a "gear-pod" (which can be reversed for different ratios, or removed entirely). The vehicle will also carry stretchers, and, because it has a bicycle seat, it can be ridden. Several of these vehicles plug into each other to form a short train.

When students suggested the use of old bicycles or bicycle parts, they regretfully had to be told that old bicycles also make good transportation devices and that parts are always needed for replacement or repair. (They may have been influenced somewhat negatively by the fact that a design student recently won first prize in the Alcoa Design Award Program by designing a power source intended for Third World use, made of brand-new aluminum bicycle parts.)



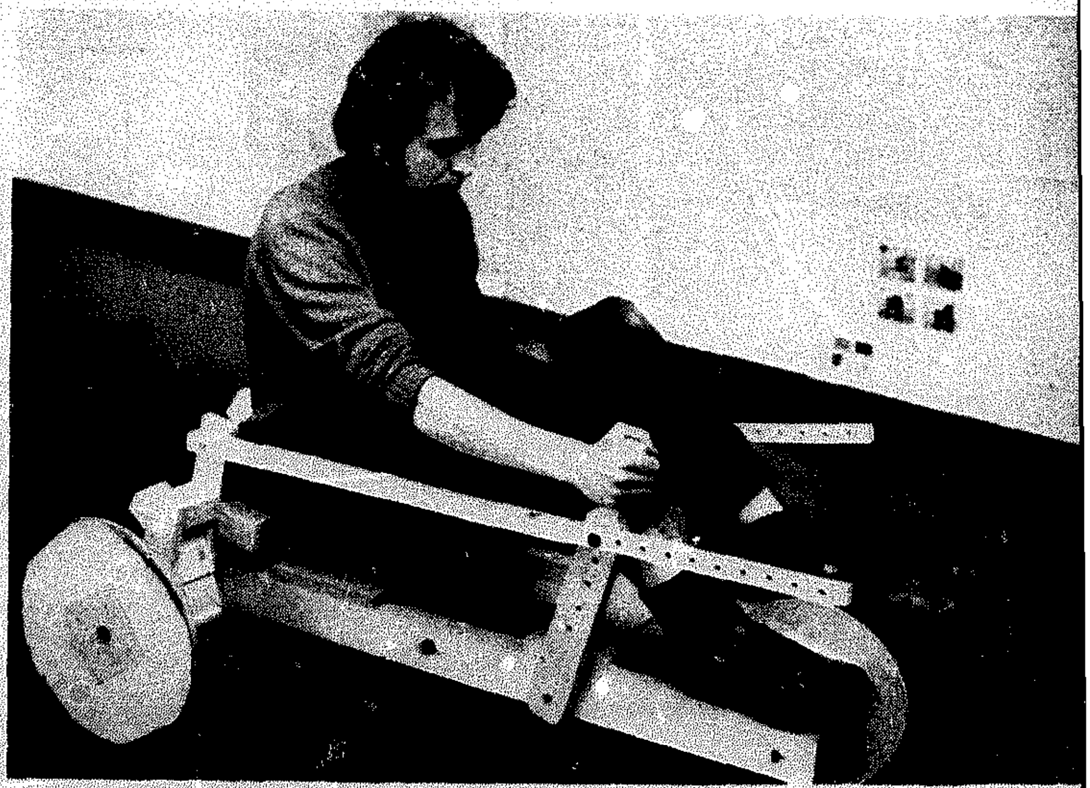


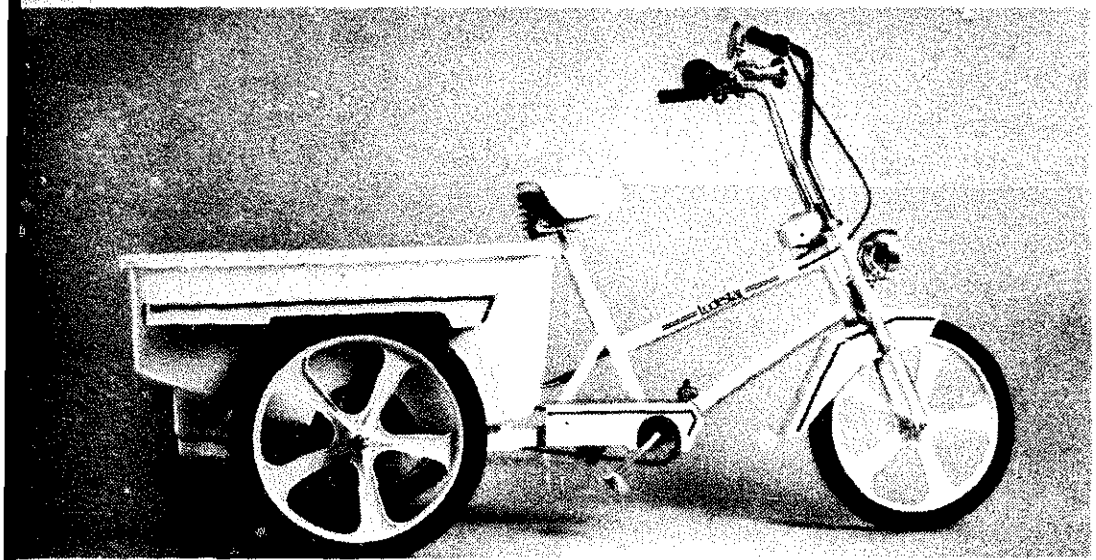


So we designed a new luggage carrier for the millions of old bicycles all over the world. It is simple and can be constructed in a village. It will carry more payload. But it will also fold down in 30 seconds (see illustration) and then can be used in its primary capacity for generating electricity, irrigation, felling trees, running a lathe, digging wells, pumping for oil, etc. After this use, the bicycle can be folded up again and returned to *its* primary function: a transportation device. Except that it now has a better luggage carrier.

As bicycles are needed as transportation devices in the Third World, this luggage carrier was designed to flip down and be used as a temporary power source when needed. Its construction is within the scope of the most modest village technology. Designed by Michael Crotty and Jim Rothrock, as students at Purdue University.

BELOW: Another version of a muscle-powered experimental vehicle designed by a student in Stockholm.

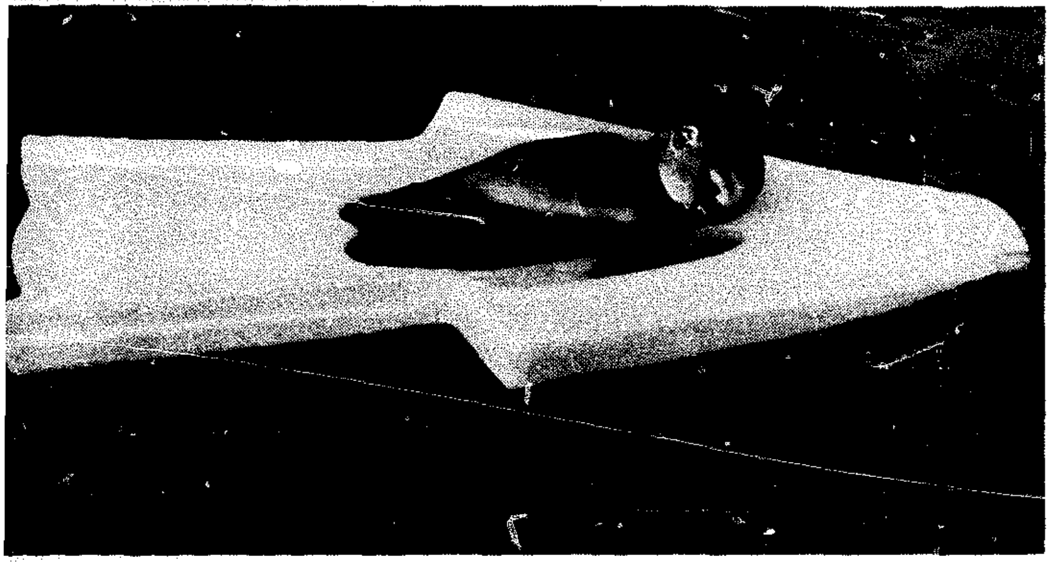




Tricycle for adults with battery power-assist. $650 each. (Courtesy Abercrombie & Fitch Co.)

A Swedish student built a full-size sketch model of a vehicle that is powered by the arm muscles and can go uphill. This in turn led us at Purdue University to design an entire generation of muscle-powered vehicles that are specifically designed to provide remedial exercise for handicapped children and adults.

For shopping and short-distance hauling of bulky packages, I have said that a simple 3-wheel bicycle with a storage compartment would do extremely well. To help the rider in going uphill, an "assist" motor that is electrically powered and rechargeable might be provided. I see on page 41 of the Abercrombie & Fitch Company's Christmas catalogue for 1970 that they offer such a vehicle for sale. In fact, if necessary, it can attain speeds of 40 mph. If the rider chooses, he can (and should) pedal, of course. However, the A & F vehicle retails for $650. I have seen it demonstrated. There is no need for the price to exceed $90. Unfortunately, one of New York's most prestigious stores has bestowed the aura of "Upper Westchester Status Object" on it, so the price now reflects this philosophy.

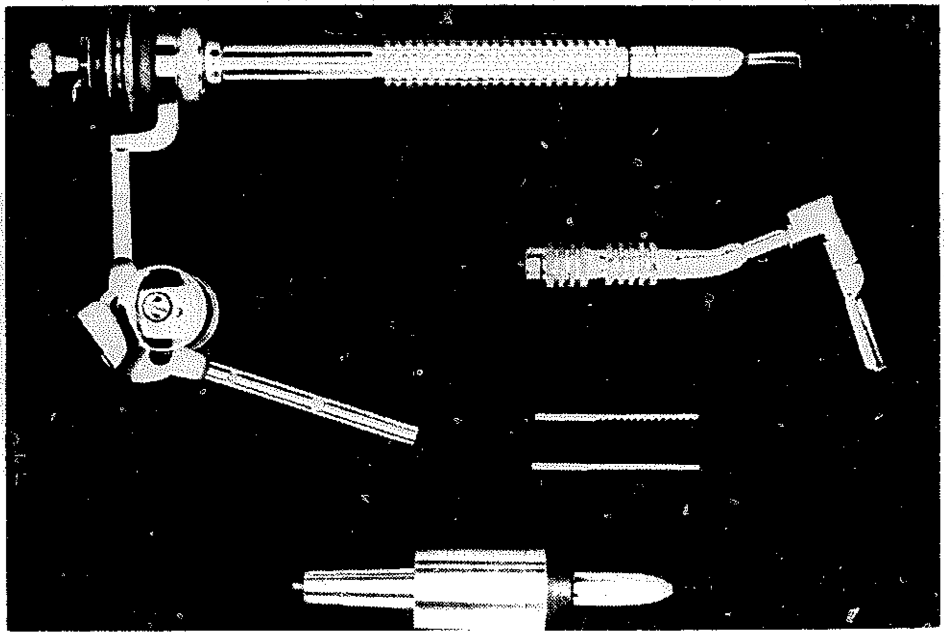


A water vehicle designed for hydrotherapy of handicapped children. Designed by Robert Senn, as a graduate student at Purdue University.

2 *Design of Teaching and Training Devices for the Retarded, the Handicapped, the Disabled, and the Disadvantaged:* Cerebral palsy, poliomyelitis, myasthenia gravis, mongoloid cretinism, and many other crippling diseases and accidents affect one tenth of the American public and their families (20 million people) and approximately 400 million people around the world. Yet the design of prosthetic devices, wheel-chairs, and other invalid gear is by and large still on a Stone Age level. One of the traditional contributions of industrial design, cost reduction, could be made here. At every Rexall or Walgreen drugstore it is possible to buy a Japanese transistor radio for as little as $3.98 (including import duties and transportation costs). Yet as mentioned previously, pocket-amplifier-type hearing aids sell at prices between $147 and $600 and involve circuitry, amplification needs, and shroud design not radically more sophisticated than the $3.98 radio.

Hydraulically powered and pressure-operated power-assists are badly in need of innovation and design.

Robert Senn's hydrotherapeutic exercising water



System of drills and saws for osteoplastic craniotomies. Design copyright © and designed by C. Collins Pippin, North Carolina State College.

float is designed in such a manner that it cannot be tipped. There are no straps or other restraint devices that would make a child feel trapped or limited in its motions. At present hydrotherapy usually consists of having the child strapped to a rope attached to a horizontal ceiling track. In Robert Senn's vehicle all such restraints are absent. Nonetheless, his surfboard-like device is safer (it will absorb edge-loading of up to 200 pounds); and the therapist can move in much more closely to the child. Later, I explain further ideas we have developed in this field.

3 *Design for Medicine, Surgery, Dentistry, and Hospital Equipment:* Only recently has there been responsible design development of operating tables. Most medical instruments, especially in neurosurgery, are unbelievably crude, badly designed, very expensive, and operate with all the precision of a snow-shovel. Thus a drill for osteoplastic craniotomies (basically a brace and bit in stainless steel) costs $125 and does not work as sensitively as a car-

penter's brace and bit available for $5.98 at Sears Roebuck. Skull saws have not changed in design since predynastic times in Egypt. As mentioned before, one of my graduating students was able to develop a radically new power-driven drill and saw for osteoplastic craniotomies, which, in wet labs devoted to experiments with animals, revolutionized the entire neurophysiological field.

The cost of health care for the "poor" is rising astronomically. Regardless of who it is that absorbs these costs in the long run, the fact is that a great deal of the high expense can be attributed directly to bad design.

From time to time, illustrations of new biomedical equipment appear. Almost invariably these are "hi-style modern" cabinets, in nine delicious decorating colors, surrounding the same old machine. Hospital beds, maternity delivery tables, and an entire host of ancillary equipment are almost without exception needlessly expensive, badly designed, and cumbersome.

4 *Design for Experimental Research:* In the thousands of laboratories doing research, most of the equipment is antiquated, crude, jury-rigged, and high in cost. Animal immobilization devices, stereo-encephalotomies, and the whole range of stereotactic instruments need intelligent design reappraisal.

With million-dollar grants from the National Institutes of Health, the National Research Foundation, and many other governmental and private foundations showering largesse upon university research departments, there has been a steady and steep climb in the price of laboratory instruments. In one case in the area of bio-electronics a simple meter lists for 8,000 per cent above the retail price of all its components, and assembly time for the unit has been estimated at less than 2 hours. A company in New York manufactures a simple electric lab timer. This unit can be purchased by amateur photographers for $8.98. The identical unit can also be purchased by research laboratories for $172.50.

A hand mixer is offered to the housewife in two versions: white enamel finish ($13.98), or stainless steel ($15.98). For laboratory use, the same unit by the same manufacturer is listed at $115.00 in white enamel and $239.50 in stainless steel. Certainly this is an area in which honest design, value engineering techniques, and cost reduction could play an important part. It might even be possible to manufacture and sell laboratory apparatus at an *honest* profit, for a change.

5 *Systems Design for Sustaining Human Life Under Marginal Conditions:* The design of total environments to maintain men and machines is becoming increasingly important. As mankind moves into jungles, the Arctic, and the Antarctic, new kinds of environmental design are needed. But even more marginal survival conditions will be brought into play as sub-oceanic settlements and experimental stations on asteroids and other planets begin to make their appearance. Design for survival in space has already become important.

The pollution of water and air and the problems of our sprawling city-smears also make a re-examination of environmental systems design necessary.

6 *Design for Breakthrough Concepts:* Many of our products have by now reached a dead end in terms of further development. Designers merely *add* more and more extra gadgets rather than re-analyzing the basic problems and trying to evolve totally new answers. Automatic dishwashers, in the First and Second Worlds, waste billions of gallons of water each year (in the face of a world-wide water shortage), even though newer systems such as ultrasonics for "separating-dirt-from-objects" are well within the state of the art. The rethinking of "dishwashing" as a system might not only make it easier to clean dishes, but would also help solve one of the basic survival problems of humanity today: water conservation. Our toilets, as mentioned previously, also waste water.

Messrs. Alexander Salosin and Viktor Prokhorov

of Donetsk in the Soviet Union have designed a thimble-like insert for men's smoking pipes. It is a gadget intended for people whose vocal cords are weak or semi-paralyzed, and it contains a generator sending out sound oscillations of 80–90 cycles per second. This makes it possible for people with paralyzed vocal cords to make themselves understood. This to is a breakthrough approach that has been suggested to American manufacturers, only to be laughed out of the office as not having enough saleability.

Humidity control in homes and hospitals is important and sometimes can become critical. In many regions of the United States humidity levels are such that humidifiers and de-humidifiers find a ready market. These gadgets are costly, ugly, and ecologically extraordinarily wasteful of water and electricity. In researching this problem for a manufacturer, Robert Senn, I, and some others were able to develop a theoretical humidifier/de-humidifier that would have no moving parts, use no liquids, pumps, or electricity. We decided to use deliquescent crystals. By combining a mix of deliquescent crystals, anti-bacteriological crystals, etc., we were able to develop a theoretical surface finish that would store 12 atoms of water to each crystal atom and release it again when humidity was unusually low. This material could then be sprayed onto a wall, woven into a wall-hanging, or whatever, and do away with the drain on electric power as well as with the noise pollution and expense of present systems.

Here again the problems are endless, and not enough solutions are coming from our own designers.

These are six possible directions in which the design profession not only can but must go if it is to do a worthwhile job. So far the designers have neither realized the challenge nor responded to it. So far the action of the profession has been comparable to what would happen if all medical doctors were to forsake general practice and surgery, and concentrate exclusively on dermatology and cosmetics.

9 THE TREE OF KNOWLEDGE: BIONICS

The Use of Biological Prototypes in the Design of Man-Made Systems

A bird is an instrument working according to mathematical law, which instrument it is within the capacity of man to reproduce with all its movements.

—LEONARDO DA VINCI

One handbook that has not yet gone out of style, and predictably never will, is the handbook of nature. Here, in the totality of biological and biochemical systems, the problems mankind faces have already been met and solved, and through analogues, met and solved optimally.

The ideal solution to any problem in design is always to achieve "the mostest with the leastest," or to use George K. Zipf's happy phrase, "the principle of least effort."

By now a definition of the word bionics is probably in order: bionics means "the use of biological prototypes for the design of man-made synthetic systems." To put it in simpler language: to study basic principles in nature and emerge with applications of principles and processes to the needs of mankind.

Dr. Edward T. Hall states in *The Hidden Dimension* that "man and his environment participate in molding each other. Man is now in the position of actually creating the total world in which he lives, or

what the ethologists refer to as his biotype. In creating this world he is actually determining *what kind of an organism he will be.*"

Even the smallest problem in the area of product design will illustrate that a great deal more than a designer with a modicum of "good taste" is needed: several years ago a new low-cost plow was designed, built, and distributed in areas of Southeast Asia that until then had used a forked stick weighted down by a rock to till the soil. After a few years it was discovered that the plows were not in use and were, in effect, rusting away. According to the religious beliefs of the inhabitants, metal makes the soil "sick," and offends the Earth-mother. I was able to recommend that the plows be dipped in a plastic compound similar to Nylon 60. And as the people were not offended by the technology of plastics, the new plows were accepted and usefully employed.

The point of this anecdote is that the use of a cross-disciplinary design team, including anthropologists, engineers, biologists, psychologists, sociologists, etc., would have prevented the original mis-design. At present industrial and environment designers are the logical foci in any design team. Their logical status as key synthesist in a design situation is not because they are superior beings, better informed, or necessarily more creative but rather because they assume their status as comprehensive synthesist by the *default* of all other disciplines. For in this age in America, education in all the other areas is a matter of increasing *vertical specialization.* Only in industrial and environmental design is education *horizontally cross-disciplinary.*

While the designer in any team situation may know far less psychology than the psychologist, far less economics than the economist, and very little about, say, electrical engineering, he will invariably bring a greater understanding of psychology to the design process than that possessed by the electrical engineer. By default, he will be the bridge.

The basic tenets on which this chapter is based are:

1 That the design of products and environments, on or off earth, must be accomplished through interdisciplinary teams, until such time as sleep-learning telepathy or the extension of the human life span make it possible and practical for the designer-planner to be conversant with all the parameters of the problem.

2 That biology, bionics, and related fields offer the greatest area for creative new insight by the designer.

3 That the design of a single product unrelated to its sociological, psychological, cityscape surroundings is no longer possible or desirable. Therefore, the designer must find analogues, using not only bionics but biological systems design approaches culled from the fields of ecology and ethology.

Man has always looked to nature and derived ideas from the workings of nature, but in the past this has been achieved on a very simple level. Technological design problems have, however, become increasingly complex during the last 100 years, and, with the proliferation of technology in our society, mankind has become more and more alienated from direct contacts with his biological surroundings.

Designers and artists especially have looked to nature, but their viewpoints have often been clouded by a romantic longing for the re-establishment of some sort of primeval Eden, a desire to get back to "basics" and escape the depersonalizing power of the machine, or by a sentimental mystique about "closeness to the soil."

And interestingly enough, virtually nothing has been written in the area of bionics. Heinrich Hertel's *Structure, Form and Movement* (1963), Lucien Gerardin's *Bionics*, and E. E. Bernard's *Biological Proto-*

types and Man-Made Systems (1963) are about all that has appeared in book form. For the most part, these three books and the various reports on bionics prepared by the armed services concern themselves with man-computer-control relationships only and deal with the interface between cybernetics and neurophysiology. There have been a few articles in the *Saturday Evening Post*, *Mechanics Illustrated*, and *Industrial Design*, but these have been largely over-simplified popularizations.

Of course, through history there have been the exceptional designers. *"A bird is an instrument working according to mathematical law, which instrument it is within the capacity of man to reproduce with all its movements,"* said Leonardo da Vinci in 1511. Fire, the lever and fulcrum, early tools and weapons—all these were invented by man observing natural processes, with the wheel possibly the only exception to this rule. And even here Dr. Thomasias presents a closely reasoned argument for the wheel having been derived from observation of a log rolling down an inclined plane.

During the last 100 years, and especially since the end of World War II, scientists have begun looking into the biological sciences in a search for answers in problem-solving areas and have managed to find new breakthroughs that are of enormous importance to today's technology. An important difference between early man and today's designs must be made at this point: While we may consider the first hammer an extension of the fist, the first rake a type of claw, and we pityingly smile at the attempt made by Icarus to fix bird wings to himself and fly into the sun, today bionics is concerned not so much with the *form of parts* or the *shape of things*, but rather, with the possibilities of examining *how* nature makes things happen, *the interrelation of parts, the existence of systems.*

Thus a psychologist, shown the diagram of a control mechanism for a recent apparatus enabling a blind

man to read by scanning letter forms and transforming them into tones, immediately recognized it as the so-called fourth layer of the visual cortex, the part of the brain responsible for Gestalt vision.

As far back as the early calculating machines, scientists recognized a similarity between the machine's function and the function of the human nervous system. With the advent of vacuum tubes, the similarity becomes even more startling. It is for this reason that one of the more active areas today in bionics lies in the field of computer design. Here, insights from computers to human brains and from human brains to computers have been gained during the last decade and a half. Professor Norbert Wiener at M.I.T. worked with psychologists, physiologists, and neurophysiologists to attempt to learn more about the human brain through the construction of computers whereas Dr. Heinz von Foerster, in work with Professor W. Ross Ashby and Dr. W. Grey Walter at the University of Illinois, has gained insight into the way computers ought to be constructed through his research on the design of the human brain.

W. Grey Walter, the British physiologist mentioned above, managed to evolve simple electronic machines that responded positively to light as a stimulus source. In other words, these machines will head for the nearest light source: a research finding much indebted to the study of the photophiliac behavior of the common moth.

Rattlesnakes are known to biologists as pit vipers because of the two pits located in the snake's snout midway between nostrils and eyes. These pits contain temperature-sensing organs so delicate that they can detect temperature changes of 1/1,000 of a degree. This might be the difference, for instance, between a sunbaked stone and a motionless rabbit. A similar principle has been used by Philco and General Electric in the design of the sidewinder missile, a heat-seeking air-to-air missile which homes in on the exhaust of jet aircraft.

Bats find their way in the dark through an echo location method: they emit a high-pitched sound which bounces off objects in their path, is picked up by their sensitive ears, and thus establishes an unencumbered flight path for them. Much the same principles are used in radar and sonar. Sonar uses audible sound waves; radar uses ultra-high-frequency waves.

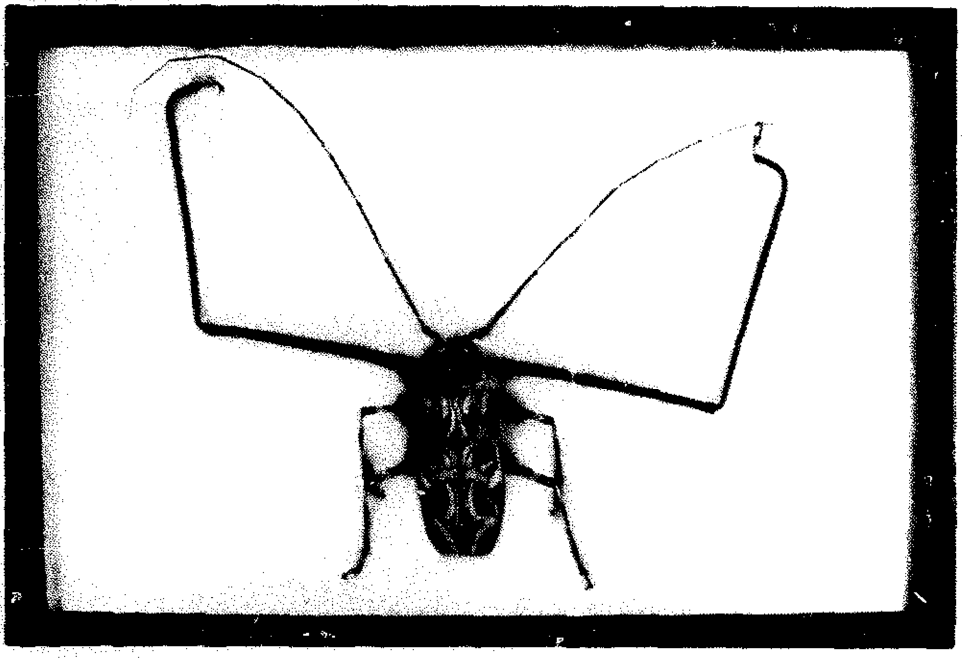
One excellent example of a bionic design investigation is a remarkably accurate speed indicator for airplanes that was developed using the same principle found in beetles' eyes. It was discovered that certain beetles compute their air speed prior to landing by watching moving objects on the ground. A study of the sense organs of these beetles has given us a present aircraft speed indicator for measuring the time elapsed between its passage over two known points on the ground and translating it into speed.

Dr. Ralph Redemske, a specialist in the area of bionics now working for Servomechanism, Inc. in Santa Barbara, California, has recently plated an ordinary honeybee with a thin coating of aluminum. Using the standard black background, this enabled him to make photographs (which were less fuzzy than a bee) of every detail of its complex structure. From this work, engineers may some day create mechanical eyes modeled from those of bees.

One of the most interesting animals, which holds many different promises of design solutions, is the bottle-nosed dolphin (*Tursiops truncatus*). The dolphin uses a radar, sonar-like navigational system which does not depend on hearing. In common with other whales, it ripples its external skin surface, utilizing this effect for navigation and increased swimming speed.

The ground effects caused by a helicopter flying in a stationary position at a distance of less than 50 feet above ground level have puzzled aircraft engineers for over a decade. Only recently, through a study of the dragonfly, are those causes beginning to be understood.

The question of energy input versus output is an-



Acroninus longimanus, male specimen showing elongated front legs. Author's collection.

other interesting one: two examples in this area are the South American fruit bat, or flying fox, and the male of a South American beetle called *Acroncinus longimanus.* In the case of the fruit bat, its truly gigantic wing-spread and great power require a comparatively small energy input. The incredibly long front legs of the South American beetle utilize even less energy input and derive great payload power.

I found the input-output disparity of the beetles to be a challenging problem. Eventually I was able to dissect several of these beetles. What is at work is a energy amplification system utilizing fluid. It is a measure of my naïveté that I immediately assumed, gleefully, that I had succeeded in a theoretical breakthrough. And it is a fact that if I had dissected these beetles some forty years ago (at the tender age of five) I would today be known as the "Father of Fluidics." In all seriousness though, there is a point hidden in this rambling anecdote: unknown to me,

fluidics existed. But it is abundantly clear that there is an infinite number of biological principles—like fluidics—lying around, waiting to be discovered.

The major emphasis in industrial and environmental design, however, will certainly lie in the ethological and ecological approach to systems, processes, and environments. In recent years, when industrial designers talked about "Total Design," they referred to two things. First, that the design of, say, a steam iron might lead also to the design of the logo, the manufacturer's letterhead, the point-of-sale displayer for the iron, the package, and possibly even some control over the merchandising of the product. At other times, "Total Design" meant in-plant work: the design of the handling machinery for manufacturing the steam iron, safety devices, traffic patterns within the plant, etc. "Total Design" in the future will mean seeing the steam iron as well as its plant and promotional gimmicks merely as links in a lengthy biomorphic phylogenetic chain reaching back to heated rocks and stove-irons, and forward to the final extinction of the phylum "steam iron" by mass introduction of "perma-pressed" and "stay-press" fabrics.

If the industrial revolution gave us a *mechanical* era (a static technology of movable parts), if the last 60 years have given us a *technological* era (a dynamic technology of functioning parts), then we are now emerging into a *biomorphic* era (an evolving technology permissive of imitations).

We have been taught that "the machine is an extension of a man's hand." But even this no longer holds. For 5,000 years, a brickmaker was capable of making 500 bricks a day. Technology has made it possible for one man, with the right kind of back-up machinery, as described in Chapter Four, to make 500,000 bricks a day. But biomorphic change obsolesces both the man and the bricks: we now extrude building skin surface, i.e., sandwich panels that include heating, lighting, cooling, and other service circuits.

While Mr. Robert McNamara, the former United

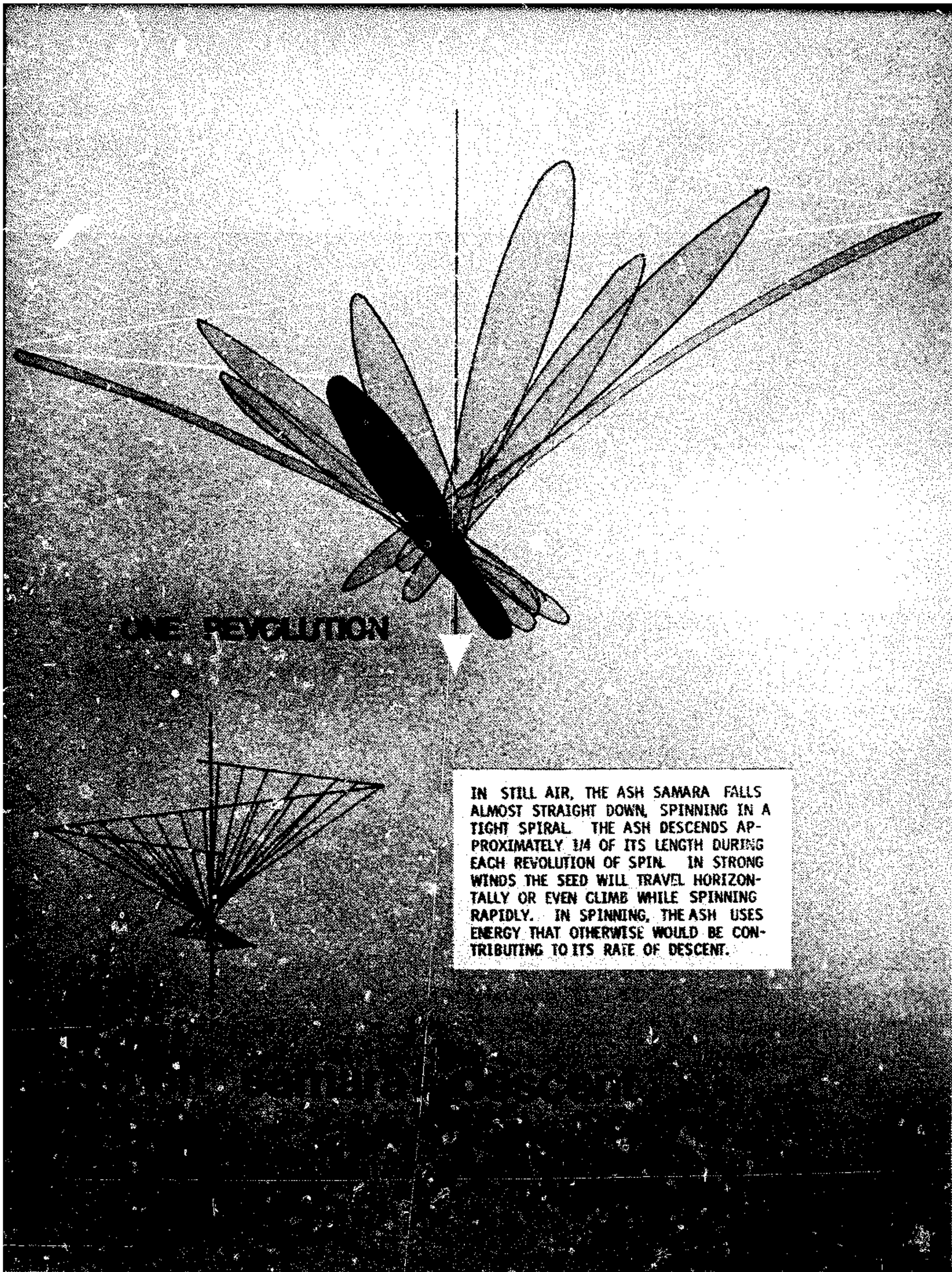
States Secretary of Defense, may often have found himself ambivalent regarding our involvement in Southeast Asia, it may be salutary to think that the same Mr. McNamara, while with the Ford Motor Company, shared the then prevailing automotive infatuation with tailfins, hood ornaments, and other small and neo-Freudian ephemera. Had the American automotive industry brought its production know-how to something like the self-generating styrofoam domes developed by Dow International, some 250 million shelters might have "grown" in Southeast Asia by now, and the sociological pressures leading to civil wars and American involvement might never have happened.

This total chain of design can probably be best explained anecdotically. Consider the fact that the absorption of 10,000 pounds of Radiolaria establishes 1,000 pounds of plankton, that 1,000 pounds of plankton establish 100 pounds of small marine animals, these in turn create 10 pounds of fish, and it takes 10 pounds of fish to put one pound of muscle tissue on a human being. The frictional losses in the system are simply staggering. With 168,000 species of insects in North America there is 6 to 8 times as much insect protein living in a 40-acre field as beef protein represented by grazing cattle thereon. Actually, we do eat flies; it's just that we process them through grass, cows, and milk first.

It may be argued that the "average" industrial designer or design engineer concerned with research and development lacks a sufficient background in the biological sciences to utilize biology meaningfully as an inspirational source of design. If we attempt to define the word "bionics" in its narrowest sense, that is on a cybernetic or neurophysiological level, this may be true. But all around us are manifestations in nature of rather primitive structures that have never been properly investigated, exploited, or used by designers, biological schemes that bear investigation and are accessible to anyone free for a walk on a Sunday afternoon.

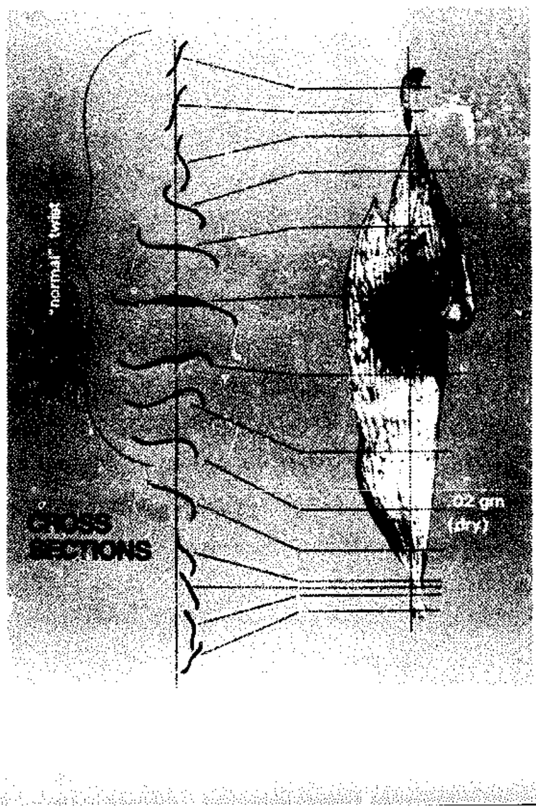
Take seeds, for instance. A simple maple seed (*Aceraceae saccharum*), when released from just a few feet off the ground, will fall in a very definite spiral pattern. This method of air-to-ground delivery has so far never been applied in any significant way. In Chapter Five, I described the use of artificial seeds as part of a system for soil erosion control. One of the more interesting applications of the maple seed's flight characteristics discovered by a design student was a new method of extinguishing forest fires, or rather, getting fire-extinguishing modules into inaccessible parts. An artificial maple seed some 8⅔ inches long was constructed out of inexpensive, ultra-lightweight plastic. The seed portion contained a fire-extinguishing powder. Experimentation and investigation showed that when maple seeds were released above a fire, they would naturally be caught up in the thermal up-drafts above the flames. If, on the other hand, the seeds were *forced* below the up-draft area and into the semi-vacuum below, their flight pattern would re-establish itself, and they would, in fact, fly towards the hottest part of the fire. To return to the plastic maple seeds. Thousands of these encased in time-sacks would be dropped from airplanes. The sack would rip open once it had plunged under its own gravity to below the up-draft area. Then thousands of plastic, expendable maple seeds would circle towards the hottest part of the fire, and here, their casing consumed by the flames, the fire extinguisher would be released. This is by no means a way to put out forest fires. It is, however, a way of getting at canyons and other areas that are normally not accessible from the ground or to smoke-jumpers.

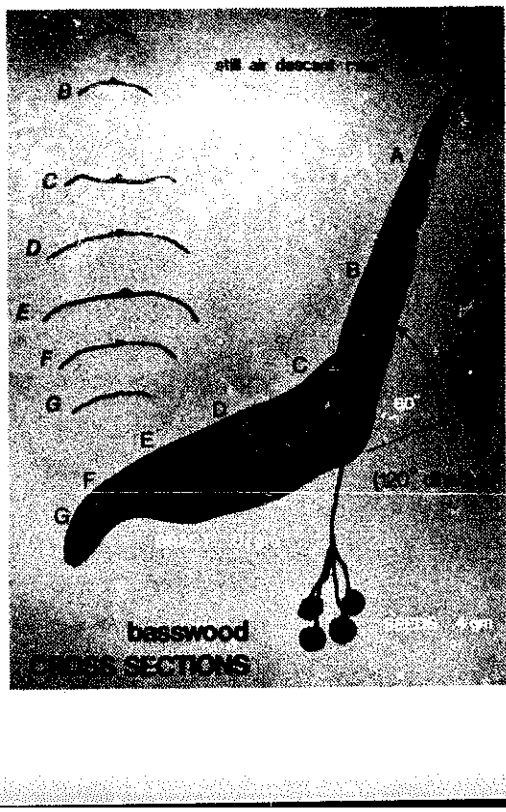
Reforestation of the extreme northern tundra areas of Alaska, Canada, Lapland, and the Soviet Union, as well as the restocking of these areas with fish, could be achieved through water-soluble maple seeds that contained seed spores or fish eggs. Naturally these artificial maple seeds could also easily include nutrient solutions, serve as thermo-protectors, or carry fertilizer.



Four examples of research into aerodynamic behavior of seeds. Graduate team research under the author's supervision by Robert Toering, John K. Miller, and Jolan Truan, as students at Purdue University.


1 cm
single fruit
core
3 cm
sycamore or
buttonwood
Platanus occidentalis


"normal" twist
.02 gm
(dry)
CROSS
SECTIONS


B
C
D
E
F
G
A
B
C
D
E
F
G
basswood
CROSS SECTIONS

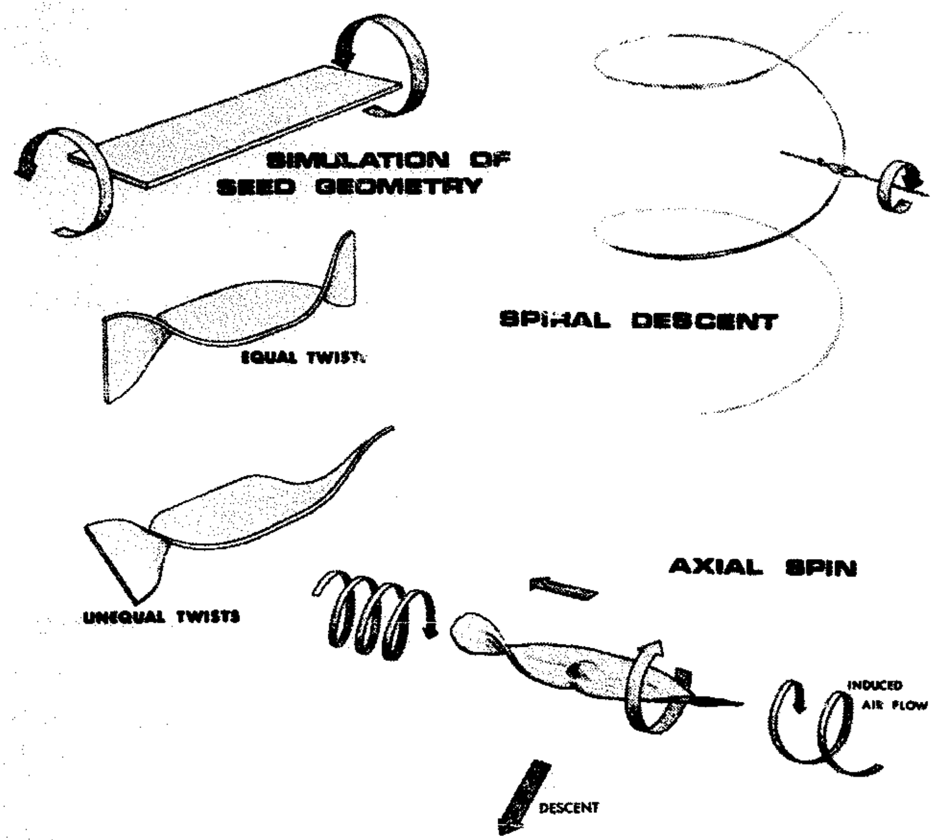
The random spreading of almost any material can be achieved through artificial maple seeds; tolerances are reassuringly broad: I have constructed artificial maple seeds that performed optimally with a wing-spread up to 46 inches. At the other end of the scale, maple seeds only $\frac{1}{4}$ inch long can be operational.

The seed of the white ash (*Fraxinus americana*) has characteristics very similar to those of the maple seed. In still air the seed falls almost straight down, spinning in a tight area. In a strong wind the seed will travel horizontally or, because of its lightness, climb for a while while spinning rapidly. If the seed's mass were concentrated into a small solid sphere, it would fall much faster, due to the decreased surface area, which would decrease the frictional drag acting on the body. However, if the seed were a hollow sphere of the same mass and with the same surface drag, but did not spin, it would fall still faster. Thus we see that the spinning actually helps to slow the seed's descent. This is due to the fact that in spinning, the seed uses energy that would otherwise contribute to its rate of descent.

Basswood seeds (*Tilia americana*) are distinguishable by their unusual flight pattern. The "wings" force a spinning motion as the seeds slowly descend, drifting with the wind in spite of the (comparatively) great weight of the double-seed which sticks out from the wing part on bifurcated extenders.

The flight characteristics of all of these spiraling seeds have not yet been studied sufficiently. The spiraling behavior of such seeds, artificially created in media other than air (water, oil, gasoline, etc.) or in near-vacuum or different gravity situations, may also prove a rich source of design concepts. We shall concern ourselves with the behavior of only one other seed in this group.

The falling Ailanthus seed (*Ailanthus altissima*) falls spinning rapidly about its longitudinal axis, making one complete revolution while descending about one quarter of its length. The physical geometry of



An example of research into the aerodynamic properties of seeds in flight. This example is the Ailanthus seed. Graduate team research by John K. Miller and Jolan Truan, Purdue University.

this seed can be approximated with twisted paper as shown. In the first simulation, the twists produced at each end are equal, which only very rarely occurs in nature. In this case the seed descends, in still air, along a straight line, at approximately a 45° angle to the horizontal. If, however, the twists are unequal, as shown in the second simulation, the seed follows a path that combines a spiral action and a screwing, axial spin at the same time. The twisted end pulls air from the vicinity of the tip of the seed in towards the center of the seed. This produces a high-pressure area around and under the seed, which slows its descent. When the twists are equal, they both push the same amount of air towards the center, producing no unequal forces.

However, when the twists are unequal, the end with the greater twist will pull more air, producing a lower pressure in the vicinity of that end. Therefore, the seed is being acted upon by unequal forces. The seed tends to slip axially towards the lower pressure area. Thus, instead of following a straight line, the seed descends in a spiral path. The combination of axial spin, slip, and spiral descent gives a very slow and almost random flight pattern to each seed.

Seeds of the wild onion (*Allium cernuum*) and the salsify plant follow flight patterns of an entirely different configuration. The wild onion seed is a delicate structure of radiating, lacy, "umbrella" type formations. Dozens of these form a spider-web-like ball around the plant's central hub. As shown, the umbrellas are closely interconnected and inverted slightly. When released, the delicate filaments flatten out and lose their convexity. They fall like tiny parachutes, only at a much slower rate. Because, unlike parachutes, they possess a flat, disc-shaped top consisting of scores of finely interlaced hairs, their rate of fall, directionality, etc., may be applicable to uses far different from those of conventional parachutes. Their lacy mantle also would foil radar detection.

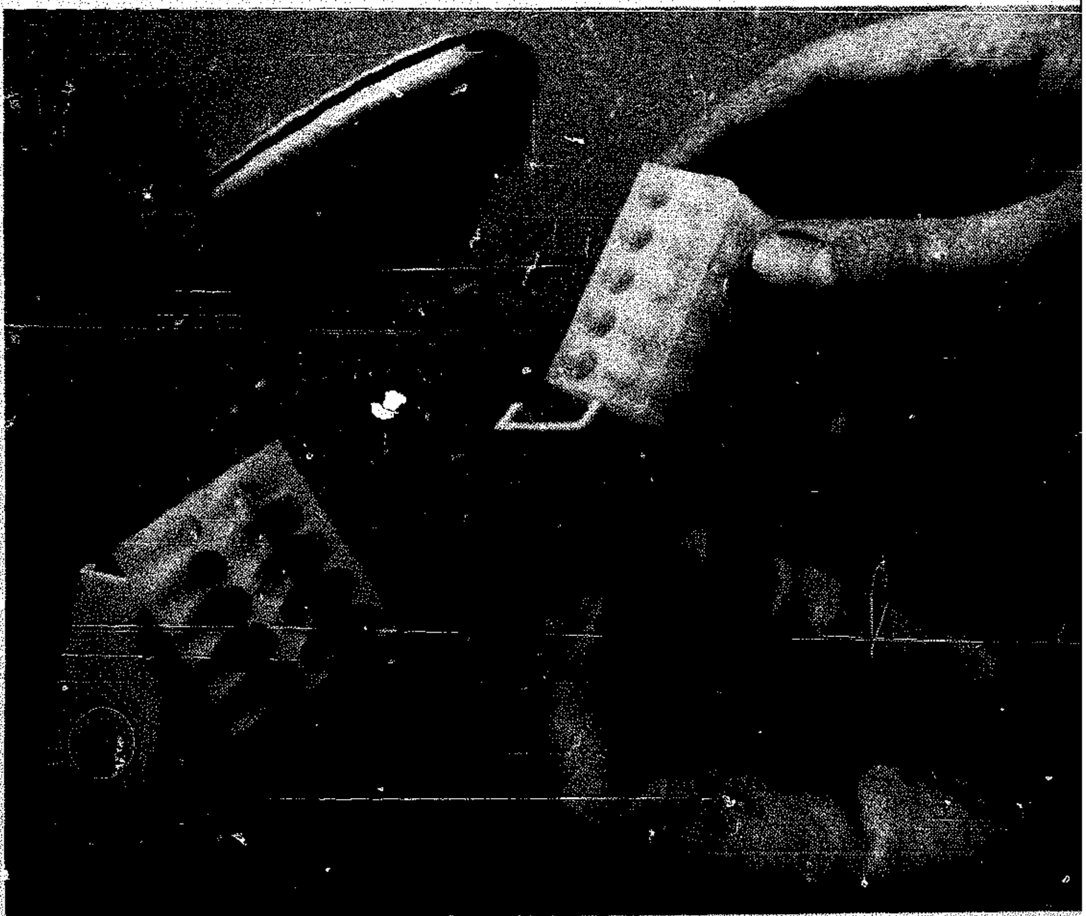
Anchorage, grappling, and hook-closures are another seed characteristic. The common cocklebur (*Xanthium canadense*) will cling to an animal's fur or, for that matter, to a man's trousers when he walks across a field in autumn. The specific hooking action has been adapted to "Velcro" nylon closure strips. Here a female surface of tiny loops and a male surface of tiny hooks are biaxially oriented. When pressed together, they can be pulled apart only in one direction and resist parting along all other axes. As mentioned above, this principle has been used in the basic Velcro closure for clothing, but has also recently been adopted for the upper-arm bands used in determining blood pressure; also recently American astronauts wearing the male part on the soles of their feet walked on dropcloths consisting of the female part that were lashed

to the exterior of a space capsule, thus making walking in a null gravity situation possible.

Explosive-force seeds—seeds that, because of the interior construction of the seed pod, are hurled 20 feet or more—will provide another useful area of research. Specifically the seed of a small berry, *Hubus arcticus*, growing only in the Lapland section of Finland, would repay investigation.

The very simplest growth characteristics of almost any plant may provide the solution to imaginative design problems. Thus the growth of an ordinary green pea may become instructive. If the pea is permitted to "go to seed," at one growth stage a string at the back of the peapod ceases to grow. As the rest of the pod continues to enlarge, within a few days it very slowly opens, and the pea seeds are slowly raised above the level of the pod. A manufacturer of suppositories for

This package was bionically derived from a pea pod. Author's design.



children was persuaded to adopt this concept in his package. Hitherto, each suppository was separately wrapped in silver foil, a dozen or so to a box. The parent, when unwrapping them, would soon find three quarters of the glycerine substance under his fingernails, with the suppository, of course, now de-sterilized. By creating a package of polyethylene that had been purposely miscast, this problem was solved. The package had been so cast that the "memory" of the plastic was its "open state." The suppositories, sterilized, but with all need for wrapping gone, would now be inserted, and a high-impact styrene closure would slide over the top. The small polyethylene package would now be under tension. Its purposeful miscasting would act like the string on the back of the peapod. When the styrene top was gently slid off, the package would open very slowly and the suppositories gently be forced up and out. Closing the package would merely mean squeezing it gently together (thus forcing the remaining suppositories back down) and sliding the styrene retainer-top back on.

Nothing has been said about insulating, heat-storing, protection from cold, and many other properties possessed by seeds.

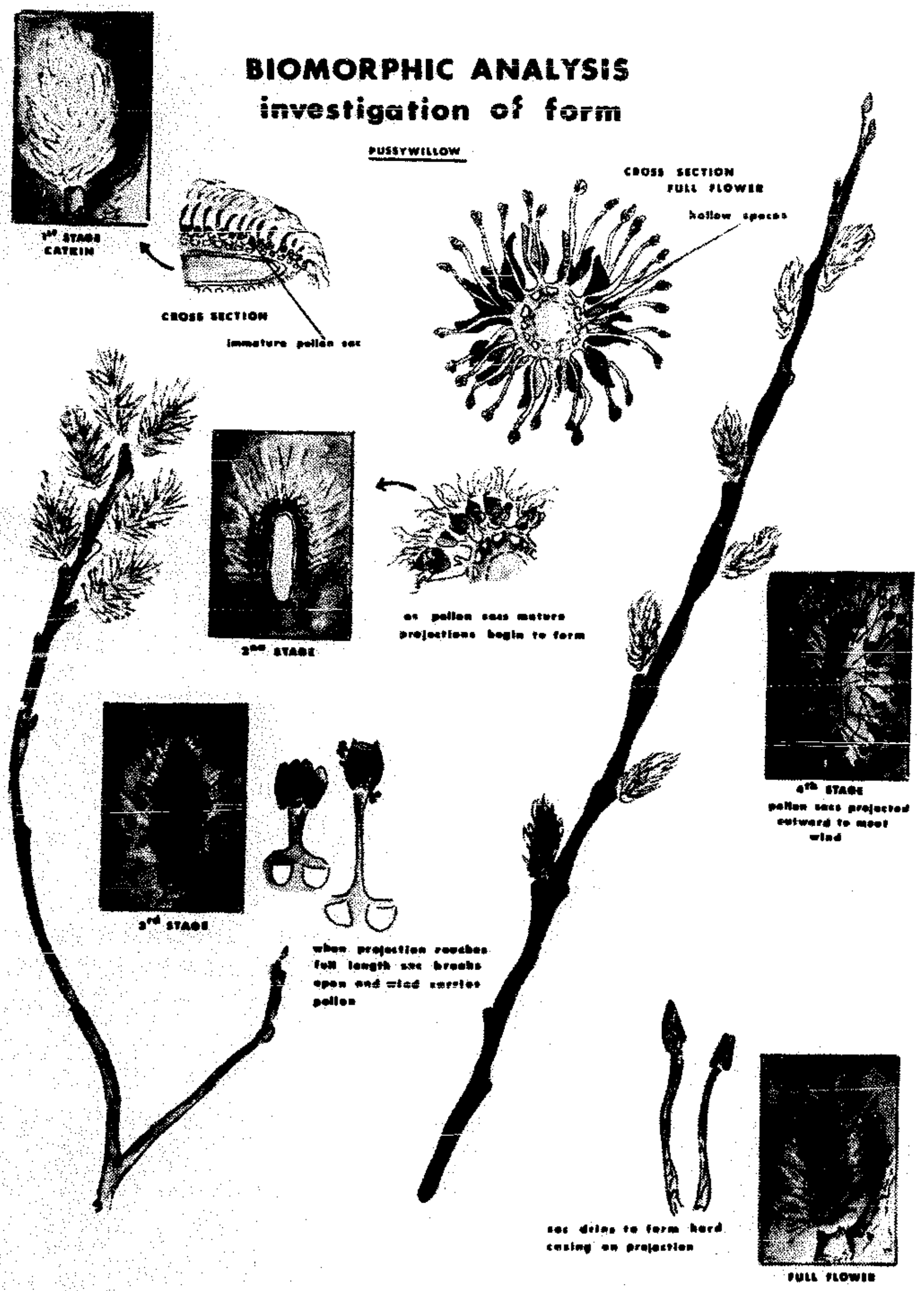
An equally large area for bionic design investigation lies in the field of botanic architecture, such as growth patterns, cells, and growth rate of bamboo shoots, the architecture of a rose, various stem configurations of plants, and the properties of mushrooms, algae, fungi, and lichen. Regarding this last item let me discuss an example (with indebtedness to William J. J. Gordon):

In facing the problem of repainting the interior of buildings, the cost of paint, labor, and depreciation has to be considered. It is an obvious fact that a freshly painted room may look beautiful for several days or weeks, but the slow, inexorable process of deterioration starts. Let's try (still with Bill Gordon) to isolate the problem. Paint is a substance which "looks good" when first applied to the wall but looks more and more

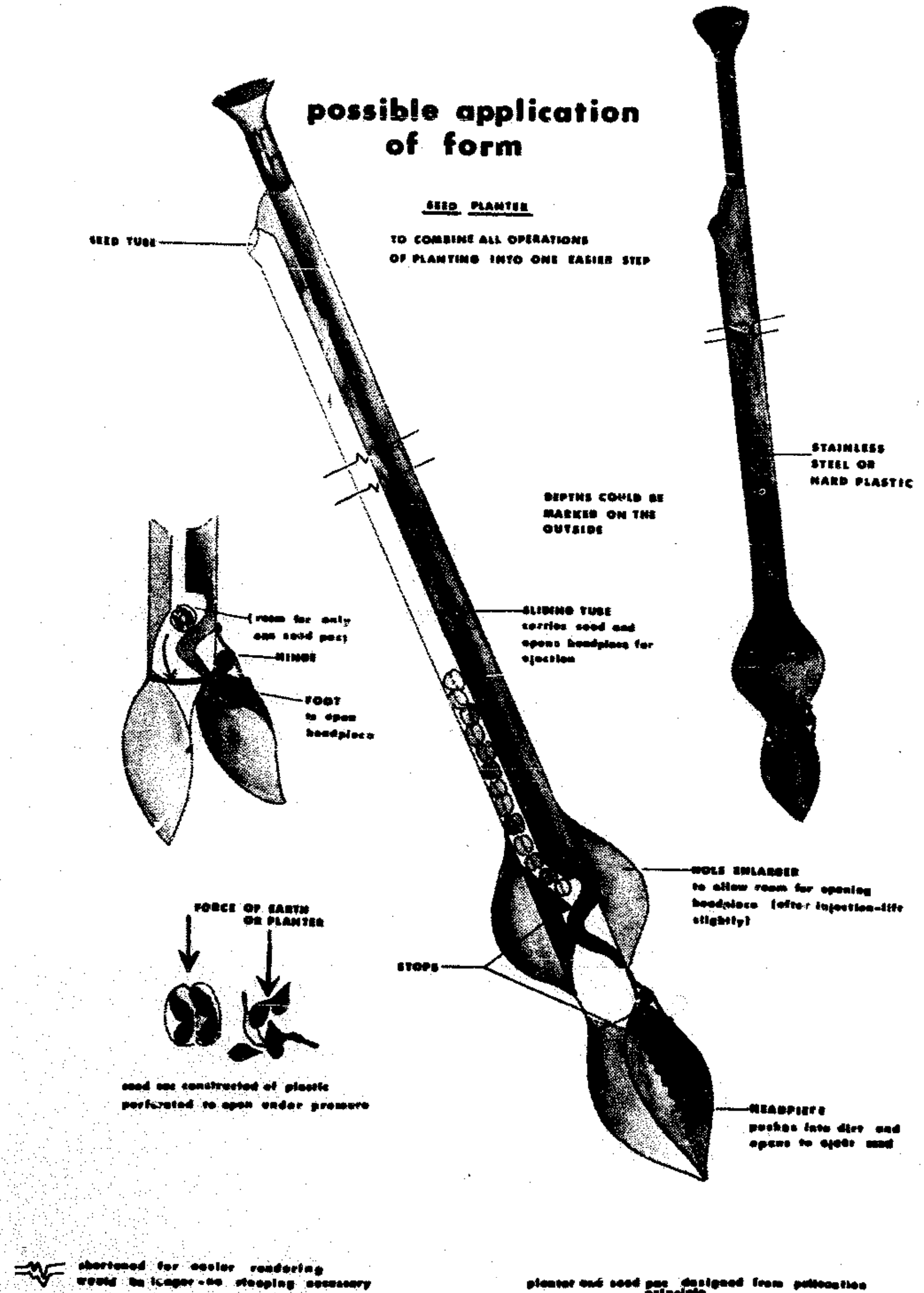
dilapidated as time goes on. The problem then: Is it possible to find a substitute which, when first applied to the wall, may look unpleasant but which will be self-improving and self-maintaining? The answer is not far away. Lichen (a symbiotic growth relationship between algae and fungi) comes in nature in a selection of some 118 "delicious decorator colors." We could theoretically select the lichen of our color choice, spray it on a wall together with a nutrient solution and just sit back and relax. Obviously the wall may be a splotchy-looking mess at first, but as the lichen begins to grow, an even color will result. Unfortunately, the designer may be obliged to speculate as to whether people can be motivated to enjoy shaggy walls. But a serious application is possible. Nearly all lichens grow a height of approximately one and a half inches, and as they are not affected by such temperature extremes as 30° below zero or 125° F., one direct use would be to plant them, instead of grass, in the center median of the New York Thruway. Because mowing costs of the New York Thruway Authority at present amount to some $2.5 million annually, this would be a great saving indeed. Furthermore, color-coding might be brought into play: the Berkshire cut-off could be planted in, say, blue, and the Ohio cut-off in red.

The growth patterns of the pussy willow have led a student to evolve a seed-planting tool that could be used in the underdeveloped areas of the world where the soil is poor and hard. This simple hand tool utilizing a basic bionic principle could be of great use specifically in Central India, Shansi, and Sinkiang, as well as the Mongolian People's Republic. Furthermore, the tool is simple and maintenance-free, so that it might be used by relatively unsophisticated people in the Central Kalahari Desert.

Turning to an entirely different area now, let us see how we can exploit the world of crystallography. If asked to fill completely two-space with polygons of the same type and size, there are only three ways in which the job can be done: a grid of equilateral tri-



First year freshman student project in bionic reconfiguration of a pussy willow. The second plate device for planting seeds in extremely hard soil



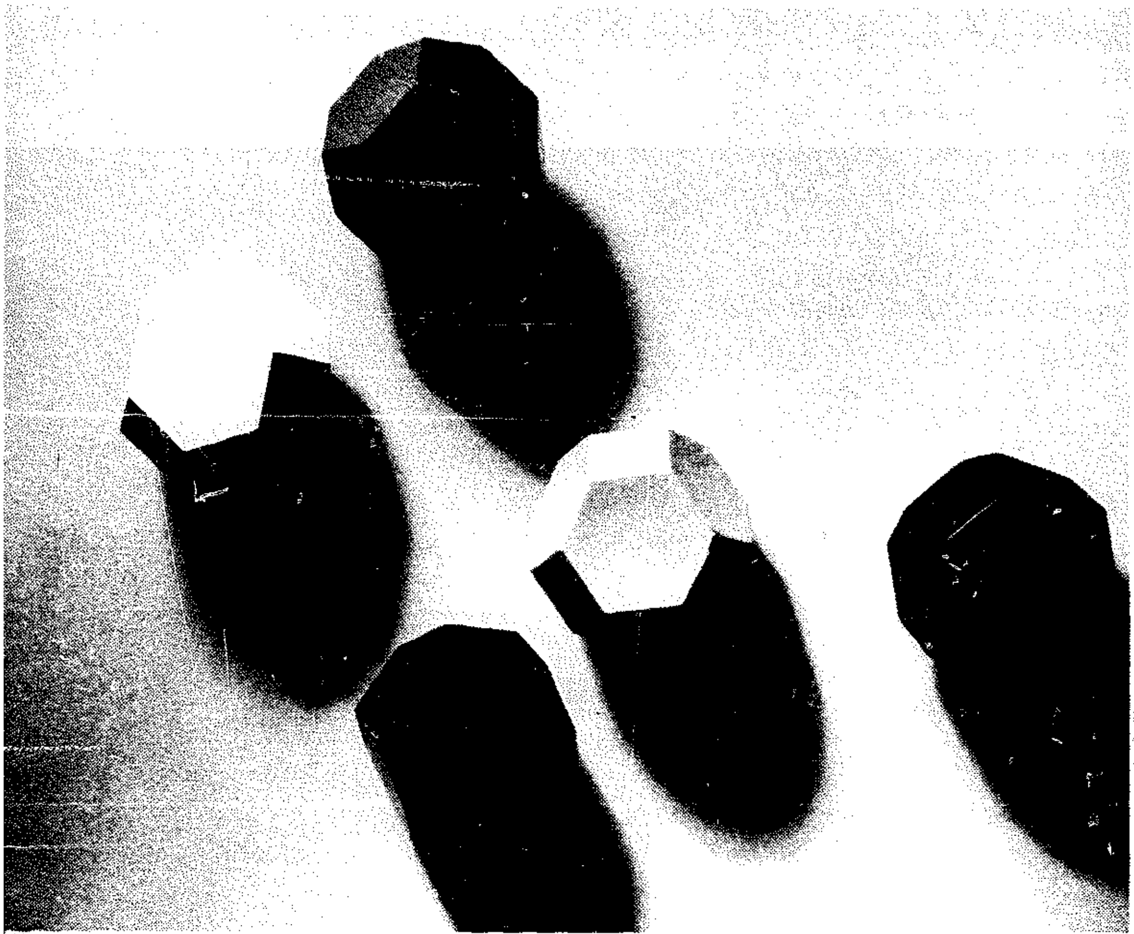
search. The first plate shows research into the
is an *application* of these basic principles to a
in underdeveloped countries. Purdue University.

angles, squares, or hexagons. Even though the number of polygons is infinite, we cannot derive a complete "space-fill" from them. Octagons, for instance, require small squares for fill-ins; with pentagons the job is impossible.

If we attempt the same thing in three-space, there are again only a very limited number of possible solutions. We can use bricks, which are, after all, a type of square-ended prism. For the same reason we can also utilize equilaterally-triangular-ended prisms or hexagonal prisms. Proceeding with any of these three prisms, we have merely built a two-dimensional construct in space. Using any of these three grid patterns, we can make a wall as high or long as we wish; its depth, however, will be that of one brick. True integration in three dimensions has not taken place.

If we derive our shape from the field of crystallography and semi-regular polyhedra, we will find that there is one shape, and one shape only, that makes a stable, fully three-dimensionally-integrated space grid possible: the tetrakaidecahedron.

Tetra (four) kai (and) deca (ten) hedron: a fourteen-sided polyhedron consisting of eight hexagonal and six square faces. A number of these will cluster easily in space because their angles of incidence and adherence make the job very easy. If we examine one of the shapes, we will find that it is rounder than a cube but squarer than a sphere. This may lead us to feel that it can resist pressure (either from without or from within) better than a cube but not as well as a sphere. True, but only for a single solid. If we cluster a series of spheres of the same size (balloons for instance) like a cluster of grapes and subject them to equal and steady pressure, for instance, by submerging in water, we will find that little pressure areas (in the form of convex, spherical, triangular pyramids) build up between our balloons. If pressure is permitted to build up more at some point, the balloons will collapse into their most stable shape: a cluster of tetrakaidecahedra. The tetrakaidecahedron, in fact, is the



Tetrakaidecahedra: archimedian solids that close-pack in three-dimensional space.

idealized shape of the human fat cell, as well as many other basic cellular structures in nature.

Here again a series of tetrakaidecahedra were handed to students for design exploitation. Many completely new design solutions resulted. By building huge tetrakaidecahedral cells 38 feet in diameter, it was possible to construct a sub-oceanic shelter area for men and materials that might be used for sub-ocean mining, oil drilling, etc. Each cell consisted of three floor levels; a cluster of between 30 and 90 of these cells would constitute a sub-oceanic station.

By reducing the diameter of the cells to ⅛ inch, a new type of radiator for an automobile was evolved,

exhibiting more surface areas and containing more water.

A folding, semi-permanent vacation house, sleeping 20, could be, in its knock-down stage, transported in a standard VW camper.

By again building the tetrakaidecahedra to a 38-foot module, a central tower could be erected, 11 units or 418 feet tall. Twenty-eight more units of the same size could then be attached in spiral form, surrounding the central core. With each unit being tri-level, the result is a luxury apartment building. The central core tower would carry stairways, air-conditioning conduits, elevators, water, heat, and electricity. In addition, any given central core unit (also being tri-level) would house bathrooms, kitchens, and other service rooms, each level housing rooms for the closest cantilevered spiral unit. The 3 floors of the exterior spiral unit could be given over to living, entertainment, and sleeping areas, with the hexagonal roof of each acting as a combination heliport and garden. Because of the ease with which further omnidirectional units can be "plugged in" or, for that matter, "un-plugged," each tetrakaidecahedron that is part of the exterior spiral could easily be air-lifted and plugged in other core units in different locations of the world. It is obvious that the same construction might also serve as a constantly contracting or expanding grain silo, etc.

When the first visual model of this structure was removed from its base, I attached a line to it and dragged it through water (much like taking your dog for a walk on a leash). It has excellent motion characteristics in water. This opens the way for constructing huge hollow tetrakaidecahedra out of ice (reinforced with algae), pumping them full of crude oil, and towing a string of these spiral clusters across the Atlantic by submarines, thus eliminating the need for tankers.

The answer most elegant technologically, however, lies in the field of space stations. Assume that a basic cluster of tetrakaidecahedra (each tri-level and

38 feet in diameter)* numbering 48 single units were to be put in a locked orbit 150 miles above earth. This unit could house a labor force of 300 men. If we now place further single cells in orbit we will find that (because of the many angles of incidence and adherence, mentioned above) 300 workers can attach another 50 units in a 24-hour work period. At this point the station (which incidentally would provide enough centrifugal spin to give a semblance of earth gravity from a central atomic pile) will house 600 people. After 2 days of work it will house 1,200 workers, 9,600 at the end of 5 days, 307,200 at the end of 10 days and 9,830,400 at the end of 15 days. In other words, it would be possible to absorb the entire populations of, say, Finland and Austria, or else all of Greater New York, in 2 weeks, *with all of these people in tri-level structures*. Now give the whole construct a push, and when it arrives at, say, Mars, Alpha Centauri II, or Wolf 359, it will be possible to decant people *and their homes*, establishing a city at the same speed as people can be landed.

All this experimentation was done during 1954–1959. Now other exploitations of crystalline forms are possible. William Katavolos of New York has suggested that cities could be "grown." With recent breakthroughs in Russian crystallography and our increased abilities to grow large hollow crystals, it may be possible, before long, to "seed" an entire city and move in when it is fully grown.

The snub rhomboicosadodecahedron, consisting of 80 equilateral triangles and 12 pentagons, lends itself quite naturally to the erection of dome structures. While these domes bear a generic resemblance to Buckminster Fuller's geodesic domes, they are in fact

* The 38-foot-diameter module has been established as a "principle-of-least-effort" structure. In other words, it exploits sandwich-skin panels to their utmost. Larger constructs are feasible, of course, but only with a sharp rise in cost.

simpler to erect, for all sides are straight and of equal length, and all angles identical.

The articulation of a snake's skeleton finds its application in a variable curve ruler by Keuffel & Esser Company. Again it may be worthwhile to point out that in this, as in all other cases, bionic design application never means copying by establishing a visual analogue. Rather, it means searching out the basic, underlying organic principle and then finding an application.

A whole group of beetles: *Propomacrus bimucronatus, Euchirus longimanus, Chalcosoma atlas & Forma colossus, Dynastes hyyllus & centaurus, Dynastes hercules & Granti horn & Neptunus quensel,* the *Megasomae* (*elephans, anubis, mars, gyas*), and the *Goliathi* (especially *Goliathus Goliathus drury, atlas, regius klug, cacius, albosignatus, meleagris* and the *Fornasinius fornasinii & russus* as well as the *Meoynorrhinse & Melagorrhinae,* the *Macrodontiae* and especially the *Acrocinus longimanus L.* [males only]) have "front-end" handling mechanisms that are startling in their variety and challenging in their complexity. None of these has ever been intelligently exploited.

Even in mentioning some random thoughts on shell structures and sea shells, regeneration, exoskeletal structures, various propulsion systems in fish, the swimming behavior of snakes, "free" soaring in flying fish, we barely scratch the surface of a few of the areas that will yield to bionic design development.

John Teal, professor of human ecology at the University of Alaska, is attacking the problem of the musk ox. With 48 chromosomes, the musk ox is actually not an ox but related to the goat and antelope. Also, there is no musk. The fur of the musk ox is actually better than wool in terms of moisture-shedding and heat-retaining properties. John Teal has set for himself the rather unusual job of domesticating musk oxen and eventually giving the results of his studies to Eskimo tribes and Laplanders all across the north-

ern tundra belt of the world. A completely new human ecology and social pattern should emerge among these deprived northern people, based on a spinning and weaving trade. At present, the normal ratio of the musk ox birth-rate is three females to one male, a problem that can be eliminated through multiple-birth-hormone injections. One of the reasons why Dr. Teal's work is so unusual is that no musk ox has been domesticated by man in nearly 6,000 years.

Mere odd speculations about the possible future domestication of microbes may open entire new vistas in design-planning, bionically, for medical applications.

In some areas of design, almost direct translations of natural phenomena can be used. In Düsseldorf in 1940, a gigantic vertical turning machine was constructed by having the interior "sperm" machine build the rest of the machine around itself.

Greater London, with a population close to that of New York City and with an unbelievably primitive and leaky water supply system, nonetheless uses only one fourth as much water as is consumed in New York. The reason is a biomorphic one. D'Arcy Wentworth Thompson quotes Roux in formulating the following empirical rules for the branching of arteries and leaf venation:

> 1 If an artery bifurcates into two equal branches, these branches come off at equal angles to the main stem.
> 2 If one of the branches be smaller than the other, then the main branch or continuation of the original artery makes with the latter a smaller angle than does the smaller or lateral branch. And
> 3 All branches which are so small that they scarcely seem to weaken or diminish the main stem come off from it at a large angle, from seventy to ninety degrees.

The water supply of London was laid out according to the above rules and, in spite of marginal losses, represents a biologically stable system.

In some fields "by-passing" characteristics are beginning to make their appearance. Sonic thesia, a system used recently in dental work, equips the patient with a pair of stereo earphones through which he listens to pre-recorded music. A third stream broadcasts a continuous screaming or wailing sound which the patient has to tune out continuously with a pain control. The patient becomes so task-oriented that little or no pain is felt because nerve endings and pain receptors are being by-passed.

In a similar way, a Bell Telephone Systems proposal to give people a standard billing per month, which would permit unlimited station-to-station direct-dialing calls anywhere on the continent, makes a great deal of sense, because right now billing procedures for individual long-distance calls cost more than the phone calls themselves. When an operator broke in on your local nickel telephone call in the thirties, it was still good business to do so. Today, with fully automated equipment, communication satellites, and a lack of operators, this no longer makes sense even on a long-distance basis. Surely world-wide direct dialing will "by-pass" present political and national boundaries.

Turning far beyond even this rudimentary "by-passing" through supra-national bodies, opens the even wider field of environmental design. Here, of course, a rather limited version of cross-disciplinary approaches has been long predicted. Design teams have included many diverse elements: architects, city planners, landscape architects, regional planners, and the occasional sociologist.

Nonetheless, it is precisely in the area of environmental design that bionic approaches and biological insights gleaned from the most recent research in ecology and ethology will be most valuable. As we create the regional smear reaching from Kansas City to St. Louis to Chicago to Cleveland to Erie to Buffalo, we also participate in creating inhabitants of prisons, slums, redeveloped slums, suburbs and exurbs, mental institutions, and $35,000 condominiums. The subtle

interaction of all these marginal types, as well as their interaction with the dominant culture, has yet to be studied, interpreted, and understood.

But even more frightening are the recent studies performed with animals under stress conditions and extreme crowding. *Fatty degeneration of the heart and liver; brain hemorrhage; hypertension; atherosclerosis with its attendant effects of stroke and heart attack; adrenal deterioration; cancers and other malignant growths; eye strain; glaucoma and trachoma; extreme apathy, lethargy, and social non-participation; high abortion rates; failure of mothers to tend their young; extreme promiscuity among the barely pubescent; a rise in homosexuality, lesbianism, and the emergence of a new sexual sub-type given to impressive and colorful, but superficial, displays of his virility, though in reality extremely passive or even asexual*; this may sound like a list of what some people think of as moral decay or the ailments of modern urbanized people, but it is not. The symptoms listed above have been observed in such widely divergent animals as Minnesota jackrabbits, Sika deer, Norway rats, and several species of birds. The common denominator has always been stress syndromes caused by overcrowding. Similar behavior patterns have also been observed among concentration camp inmates, prisoners, etc. It has caused Dr. John Calhoun of the National Institute of Mental Health to coin the accurate and lethal phrase "pathological togetherness."

Up to now environmental planning has sublimely disregarded all this.

Industrial and environmental design are one of the few fields in which the schools are ideologically in the forefront of the profession. In spite of some anti-intellectuals in the design field who have just done "a good job on a luggage handle" or "really communicated no-mow, no-grow consumer satisfaction through Sassygrass" (an outdoor nylon carpet in red, brown, blue, or green), design, as the most powerful shaping tool yet developed by mankind to manipulate himself

and his environment, will go on. The professional society meetings that endlessly and fruitlessly attempt to define industrial design might take another look at the sciences. Electricity, after all, is never defined but is described as a function, its value being expressed in terms of relations—the relation between voltage and amperage, for instance. Industrial and environmental design, too, can be expressed only as a function; its value, for instance, being expressed in terms of relations: the relation between human ability and human need.

10 CONSPICUOUS CONSUMPTIVES: DESIGN AND THE ENVIRONMENT

Pollution, Crowding, Starvation, and the Designed Environment

Nature has let us down, God seems to have left the receiver off the hook, and time is running out. . . .
—ARTHUR KOESTLER

If design is ecologically responsive, then it is also revolutionary. All systems—private capitalist, state socialist, and mixed economies—are built on the assumption that we must buy more, consume more, waste more, throw away more, and consequently destroy Liferaft Earth. If design is to be ecologically responsible, it must be independent of concern for the gross national product (no matter how gross that may be). Over and over I want to stress that in pollution, the designer is more heavily implicated than most people. By now the garbage explosion has outdistanced the population explosion, and as Professor E. Roy Tinney, the director of the State of Washington's Water Research Center, has remarked, "We have not run out of water. We have simply run out of new streams to pollute." The strength of our chemicals has grown to the point where in mid-July of 1969, one single 200-pound sack of the German pesticide "Thiodan" that accidentally fell off a barge on the Rhine was able to kill more than 75,000 tons of fish in Germany, Holland, Switzerland, Austria, Liechtenstein, Belgium, and France *and to stop a new*

fish population from forming for a time period that has been estimated at 4 years. The automobile is held accountable now for more than 60 per cent of all air pollution generated in the United States, and for an increasing amount in other Western nations.

Scientists are beginning to realize that jet aircraft pollute the upper atmosphere (as there is no "washing effect" at extremely high altitudes), and so pollutants from aircraft will circle the earth many times before settling through gravitation. Dr. Alfred Hulstrunck (Atmospheric Research Center, State University of New York) comments: "If transportation continues to grow the way it's going, it's possible the next generation may never see the sun." Were this to happen (and there is a good chance that it will by 1990), this might not necessarily spell global darkness. Instead, the "hot-house effect" might take over. Transparent to sunlight, but opaque to the earth's radiation, a blanket of moisture and carbon dioxide might raise the surface temperatures of the earth enough to melt the polar icecaps. This would, at the very least, raise sea levels by 300 feet (shinking habitable land by 64 per cent). But in all likelihood, the sudden weight shift might spin the earth off its axis.

We could continue with these examples at a faster rate than the speed at which this can be read. And so far we have dealt with "neutral" interventions, that is, things that have just seemed to happen, rather than results, or foreseeable results, of malign intent.

We need spend little time on the fact that malign intervention can pollute and kill. The 5,000 sheep killed by the accidental release of a United States Army nerve gas in Skull Valley, Utah, on March 21, 1968, bear mute witness to the dangers of chemical warfare.

But what happens when man's intentions are *benign* from the start? Through the building of the Aswan Dam, Egypt attempted to make a quick transition from 6,000 years of agricultural history to twentieth-century technology. One of the largest structures of

its kind, the Aswan Dam project was specifically designed to provide a multitude of socio-economic benefits. There would be, minimally, a 25 per cent increase in cultivated land, and electrical output would double. Unfortunately, things have not worked out like that. Lake Nasser (part of the Aswan development) retains most of the silt on which the rich Nile Delta farmland depends. The dam also impounds essential natural minerals, needed by the ecological chain of marine life in the delta. Since Aswan first started to regulate the flow of the river in 1964, Egypt has suffered a loss of $35 million to its native sardine industry; as of the spring of 1969, there are reports that the delta shrimp fishery is also declining.

Professor Thayer Scudder of Cal Tech has reported similar results in the wake of damming up the Zambezi River in southern Africa. The designers of the dam had predicted that the loss of flooded farmland would be offset by increasing fishery resources. In reality, the fish catch diminished immediately after the dam was completed, and, soon after, the lake shore bred hordes of tsetse flies, which infected native livestock and nearly aborted cattle production.

But we have learned nothing from these lessons. At the time I was writing this, engineers were designing the largest dam systems in the history of mankind for two of the world's longest rivers: the Mekong and the Amazon. The Hudson Institute's proposal for the Amazon calls for the creation of an inland sea, nearly as large as Western Europe! In Florida, the United States Army Corps of Engineers has built a series of small dams neatly across the northern boundary of the Everglades National Wildlife Refuge. This was done in order to irrigate land to be used for cattle grazing (notoriously, the least efficient use of land) and to appease the cattle-raisers' lobby. The result: the Everglades are drying up, wildlife is being destroyed, soil is becoming salinated, and parts of southern Florida are taking on the characteristics of a desert. To finish it off, there is a chance that a new jetport

(with its high decibel levels and pollutants) may still be constructed at the southern edge of the Everglades.

We tend to overlook the fact that nearly all major disfigurements of the earth have been created by ourselves. The impoverished lands of Greece, Spain, and India, the man-made deserts of Australia and New Zealand, the treeless plains of China and Mongolia, and the man-made deserts of North Africa, the Mediterranean basin, and Chile, are all proof of the fact that *where there is a desert, man has been at work.* Ritchie Calder's *After the Seventh Day* documents this. It is instructive to compare maps of the United States, covering the period from 1596 to the present. Helpfully, the earliest maps, prepared by Spanish Catholic missionaries, are of the Southwest. The desert —which now covers parts of 9 states—hardly existed at all. But as trees were cut down indiscriminately, as water run-off increased, as an estimated 200 million buffalo were eradicated, as topsoil was washed away each spring, the familiar Dust Bowls of 1830 and 1930 were created, and the deserts kept growing. The only thing that has changed is the pace of change itself. It took Alexander the Great and other conquerors nearly 1,500 years to turn Arabia and Palestine ("land of milk and honey") into a desert. A mere 300 years sufficed for the American desert. And American "know-how" has succeeded, through the use of defoliation, napalm, and the diversions of rivers and streams, in altering the ecological cycle of the southern part of Vietnam in five short years in such a manner as to ensure that part of the world turning into a permanent desert.

Of course, damage done by American know-how is visible not only in foreign countries and in our remote past. The other day I read in the papers that the city fathers of Butte, Montana, are devising plans for moving the entire city to a nearby valley, so that the Anaconda Company may enlarge their strip-mining operations. And even in space: more than 8 years ago a team of American military "scientists" exploded a

charge of crystalline metal particles in the Heaviside layer of the upper ionosphere. This was done—in spite of strenuous and vociferous objections by scientific bodies all over the world—just "to see what would happen." Inestimable genetic damage may have already been done to mankind, animals, and crops as a result of this experiment: *and we will never know, as there is obviously no control group available to us to measure the results, because all earth would be affected.*

It would be tedious to continue piling example upon examples, statistic upon statistic. For at a certain point, a feeling of deep lethargy sets in, and our reaction is: "What's the use?" or "What can one man possibly do?" If we respond in this manner, we are lost. For it is precisely by shifting problems from the trivial to the tragic plane, by forsaking a personal view for a cosmic one, that we rationalize and manage to shrug off our own personal responsibility. In *all* the above problems and more, all people are implicated, but not equally so. The designer's responsibility and implication is far greater. He is trained to analyze facts, problems, systems and to make what are at least inspired guesses regarding what may occur "if this goes on."

As of December, 1970, Los Angeles was the first place in which the total acreage used for roads and parking places *exceeded* the amount of space given over to human habitation. Obviously, the automobile is highly inefficient in many ways, and what is called for is a *designed* solution.

Recently, devices have been designed and marketed which cut down the exhaust fumes of a car. The installation of these exhaust filters has been made mandatory in some countries (Sweden) and in some states (California), and at a superficial glance, this seems an answer to the problem. But in fact it is not. The consumer is required to spend more money for installing one of these gadgets, and to continue spending more money since the gasoline consumption of

the automobile rises sharply. Finally, the device itself is quite inefficient. Even this could be justified, if the automobile performed in satisfactory ways in all other areas, but it does nothing of the kind.

The answer here must inevitably lie in a complete rethinking of *transportation as a system*, as well as a rethinking of each component part of that system. Some possible guidelines for the future already exist.

It is more than half a century now since a monorail rapid-transport system was first put into daily operation at Wuppertal in Germany. The system has proved itself to be fast and clean, and intrudes only minimally upon the physical and visual environment. Surely, monorail systems could help ease traffic congestion in many of our large city-smears. Furthermore, a technology that can send men to the moon has surely managed to discover devices better than the monorail during the last half century.

Nonetheless, we are told that the average individual in the Western world values his personal and individual transportation device, and that, especially in the United States, the family automobile has become surrounded by a whole cluster of ideas—relating to self-reliance, independence, and mobility—that once surrounded "Old Paint," in the days of the wild and woolly West. This folk mythology works only as long as we consider the automobile a sort of super-horse, and blind ourselves to its drawbacks. Once we consider the car as merely *one* link in a total transport system, alternative solutions can easily be found.

The average American today will drive his car (spatially the equivalent of 2 telephone booths or a large toilet) a distance of 60 feet around the corner just to mail a letter. On a second scale, he and his wife will drive one mile or so, once a week, to do their marketing. On a third level of complexity he may drive (quite alone in his huge steel coffin) a round trip of some 40 miles daily, to get to work. And on a fourth level, he may pile the entire family into the car (2 or 3 times a year) to visit Grandma some 300 miles away.

A fifth level exists: he knows that at any time he has the ability to jump into his car, and by driving long hours, reach California from, say, New York in a mere 5 days. He rarely does this. He flies instead and rents a car in California.

Now let us analyze this as a system. Distances of more than 500 miles can be most efficiently transversed by airplanes. Distances of between 50 and 500 miles are more efficiently served by railroads, buses, monorail systems and other, newer methods, to be developed by design teams.

Electrivan: By 1968 there were more than 45,000 electrically propelled vehicles on the roads in Britain, more than anywhere else in the world. Without them and their extremely low running costs, Britons would no longer enjoy home milk delivery, garbage collection, ambulances, or street maintenance. The post office began using them some years back. Crompton Leyland Electricars have introduced this small and spunky van. It is 9 feet long, and has all the usual advantages of an electric: no clutch, gearbox, radiator or oiliness, which give low maintainance cost, plus a 20-foot turning circle and built-in charger. It can do 33 m.p.h. and will carry 500 pounds. It is guaranteed for 10,000 miles or one year. (Courtesy: The Council of Industrial Design, England.) So there seems little need for the controversy as to whether electric cars are feasible: thousands have been on the road for years!

For distances of less than 50 miles, many devices now exist, some of which are not exploited sufficiently. New ones will be evolved by design teams. A partial listing in rising order of complexity seems in order. The simplest way to cover short distances still seems to be walking, and there is something ludicrous about millions of Americans driving a few feet to the mailbox, but solemnly "jogging" on a $276 aluminum treadmill in their bedrooms for 10 minutes every night. Roller skates may sound faintly ridiculous; they are nonetheless used in storage areas and to get around in factories in the space industry. Non-powered push scooters give excellent mobility to travelers arriving at Kastrup international airport outside Copenhagen.

An electrically powered aluminum scooter, weighing 18 pounds, foldable and, when folded, no larger than a shoe-box, with a cruising range of 15 miles, was designed and tested by an industrial design student in Chicago several years ago. This device, which would give excellent mobility without pollution or congestion in downtown areas and on large college campuses, has never been built commercially. It would allow people to get from place to place on a platform measuring 9 × 15 inches (whereas the space occupied by a Cadillac "El Dorado" measures approximately 10 × 19½ feet); the saving in space is great. It is important to note that our industrial design student in Chicago worked alone for a period of 7 months and spent a total of $425 developing his electric, handbag-sized mini-scooter. Given the $3.4 billion which General Motors alone spends for corporate research and development each year, given the facilities and design talent available, we can readily see that even this excellent scooter is by no means the last word in personal transportation.

Bicycles are used for movement within the 50-mile radius we have established, both in Denmark and the Low Countries. Many of these fold, some can be carried easily. Powered bicycles with miniature gasoline engines exist; small electric drive-assist systems

could be devised easily. Some of the vehicles designed by my students, for exercise and sport by both normal and paraplegic children, may point the way to new ways of transport. Mopeds, powered scooters, and motorcycles can be safely left out of this discussion in their present form as they are prime polluters. Finally, the automobile:

For reasons of prestige, "good taste," status, and sex appeal, as well as the easy profits guaranteed by built-in obsolescence, few intelligent changes have been made in automotive design (aside from skin-deep styling and "convenience" factors) since 1895. Most of the configurational changes have gone in the direction of largeness and sleek, "zippy" looks. Nonetheless, a few design breakthroughs such as the Bubble Simca, the two-passenger, in-line-seater Messerschmidt, and even the Morris Mini-Minor and Mini-Cooper, point the way to smaller vehicles that can, in the last two cases, seat 4 adults and a child and also store an incredible amount of luggage.

All that is needed is a new (probably electric) power plant. Because batteries today are large in size, heavy, and short-lived, such cars could recharge themselves from sockets contained in parking meters and in their home garages. Predictably, however, batteries will shrink in size and weight and at the same time gain a longer life span as industry discovers a need, and as the state-of-the-art progresses.

Some Utopian concepts such as moving sidewalks must be rejected at this time because the power expended versus the value gained is disastrously overbalanced in favor of the former.

By joining three systems, all of them in existence right now, we can find at least one viable alternative to the downtown clutter and traffic problem. If we combine (1) a fleet of battery-driven miniature taxis similar to the Messerschmidt with (2) a transportation credit card and computer billing of users at the end of each month and (3) a one-way wrist-watch-sized radio, we have the beginnings of a rational downtown

transportation system. The user could summon such a mini-taxi to his particular location with his radio (thus eliminating the biggest argument against public transport: a long walk in the rain, and then a wait at the bus stop). The mini-taxi could then take him to his specific location, again eliminating "approximate destinations." Payment would be via credit card and billed monthly. Even with thousands of these mini-taxis in downtown areas, more land (now given over to garages, parking lots, and service stations) would be liberated. Exhaust fumes would be eliminated. Larger parts of the streets could be given over to planting, parks, and walking space. At the end of the work day, users would be brought back to downtown monorail terminals, and returned to their home destinations.

Those romantic souls who would still prefer to "shift their own gears" and feel the soft purr of a high-powered sports car at their command, would find themselves in a position analogous to that of horseback riders today. At garages, located in a peripheral cycle around larger cities, station wagons, trucks, or open sports cars could be rented for a few hours, or days, of country driving. This equipment could also be rented through the transport credit card system. Howover such vehicles could not be brought into built-up areas or cities.

(It is important to stress that the foregoing scenario is highly speculative and in no way pretends to present *the* answer to urban transportation problems. It merely attempts to show one of many possible solutions and, at the same time, deliberately shows how the designer and the design team are involved along every step of the way.)

The highest density of work population in Manhattan existed until recently at the junctures of Forty-second Street, and Madison, Park, and Lexington Avenues. Here some of New York's largest skyscrapers absorb a daily working population of more than half a million people, together with food, goods, and services for this area alone. Some of the largest shops exist

within a one-mile radius. At Grand Central Station, 9 different levels of subways converge. The terminal building for 2 of New York City's 3 airports is only half a mile away. And Grand Central Station itself consists of 5 subterranean levels, and is the terminal point for most railroads. The congestion and crowding are enormous. The answer of designers and planners to this problem was to erect a 46-story office building equipped with a helicopter landing roof) directly over Grand Central Station! (This feeds an *extra* 120,000 people into the system each day.) While we are suggesting that designers make a positive commitment to today's problems, environmental or otherwise, the very least they might do in cases such as this would be to refrain completely from applying their talents and to refuse to participate in such insane and destructive acts.

Often the designer has controlled, or partially controlled, selection of materials and processes. For instance, the choice of aluminum as a better material for beer cans has been inaugurated by the merchandising staff of Alcoa. The fact remains that designers created the cans and the new "zip-openings" on them, which make them so attractive to the public. Industrial designers developed the cans, creative problem-solvers came up with the new opening method (and machines for production), and visual and graphic designers concerned themselves with brand identity, corporate identification, labels, trademarks, and selling the entire package to the public. What's wrong with that?

For one thing, the process wastes millions of tons of precious raw materials *that can never be replaced.* But more importantly, aluminum is a material that breaks down very slowly. For nearly a thousand years we will have to live with the beer cans thrown in the garbage today, or tossed casually out of an automobile last night. I have discussed Swedish experiments to develop a disposable beer bottle made of a biodegradable plastic in Chapter Five.

Beer bottles and other canned goods are not the

only offenders. Aluminum foils, while thinner, are every bit as resistant to rust, corrosion, and biological breakdown as cans. Used aluminum foil clutters up our dumps and acts as an effective shield against "breathing" by the top layer of the soil. This in turn directly affects rain absorption as well as the course of subterranean streams and natural water reservoirs. Soil temperature levels under dumps differ from those of adjacent areas by as much as 3° F. As well as creating minor climatic changes within small ecological systems, this also creates a tendency for garbage-shielded dumps to retain vital minerals, and prevent their absorption by the adjacent useful farmland. Here again imaginative designers should be able to suggest alternates to this system.

The introduction during the fifties of "aerosol" cans for most liquid and semi-liquid items under pressure has revolutionized merchandising of drugs, foods, home remedies, cosmetics, and many other items. Industry has embraced the aerosol concept eagerly: it makes it possible to sell a smaller quantity at grossly inflated prices. Almost without exception aerosol cans are so constructed that even the small amount sold to the consumer cannot be totally used. Hence, more waste. Aerosol cans manage to foul up the landscape quite as thoroughly as others, but in addition, they are potential bombs, ready to send jagged pieces of metal shrapnel tearing into the flesh of any child incautious enough to experiment with the cans under heated conditions. Designers, both industrial and graphic, are much to blame in helping with the introduction of aerosol cans.

They are even more to blame for not creating better alternative solutions to the problem. The accordion squeeze-bottle designed for the Imco Container Corporation in 1955, Egmont Arens's toothpaste bottle for Bristol-Myers of 1957, and various European systems of merchandising mayonnaise, caviar, mustard, cheeses, and other foodstuffs in tubes, point the way to better approaches. As all of these are plastic, bio-

degradable materials could be used, and the consumer would benefit additionally by getting a fair measure for a fair price.

The recent design of insulating wall sandwich panels used in buildings employs a combination of glass fibers, asbestos fibers, and a "chew" of other fibrous products. As little as one fiber if accidentally breathed in, can cause death or serious illness. While the workers are well protected by face-masks, the surrounding space must also remain clean. This has led to the installation of giant blowers—blowers which frequently feed out into the street. During the last few years, several people have accidentally breathed in this material and died as a direct consequence. In Manhattan itself the same thing has happened during careless installation of such panels in buildings or apartments (cf.: the documentation by Berton Roueché). Once again, at least a sizeable part of the responsibility lies with the designer, in designing products less liable to be mishandled or act as pollutants.

These are just a few miscellaneous examples; a list of this sort could go on almost indefinitely.

If we turn to a man-made environment for living, the story is at least equally grave. Frequently we are shown the cold, inhuman, and sterile aspect of the apartment buildings erected shortly after World War II along *Karl Marx Allee* in East Berlin. But the differences between it and similar speculative mass housing erected by insurance companies around Greater New York, or even the most enlightened "community planning" practiced in some of the Scandinavian countries, is only one of degree rather than kind. Human beings and family units have become "components" to be stored away like carbon copies in the gigantic file cases that are today's tenements. When the cry of "urban renewal" is raised, the results are frequently less humane than the situation that originally gave cause for redesign. Thus, in a recently "renewed" ghetto area located in the southeastern part of Chicago, a series of more than 30 apartment buildings (each

holding more than 50 family units), is strung out in a single 4-mile-long chain, neatly placed between a 12-lane super-highway (which cuts the development off neatly from the rest of the city) and, on the other side, a series of large manufacturing plants (with their perennially belching smokestacks) and a large municipal dump. In spite of all the old ghetto's faults, it did have a "sense of community," and that has been destroyed completely.

The inhabitants have no park, green spaces, or even lone trees within walking distance. Each family is alienated from the rest; nights find them cowering in their cell-like apartments while the juvenile street gangs exchange gun-fire down below. In just *one* of these buildings, more than one case of rape or assault occurs daily, and between 3 and 4 cases of murder or attempted murder each week! The ghetto has been verticalized neatly and turned into a series of skyscrapers. Visually all the buildings are identical and look like a series of cement slabs into which a child has carved an insufficient number of tiny windows.

This area is also completely divorced from even the most basic shopping needs. A supermarket and a drugstore are located about 500 feet from the northernmost of the buildings, and public transport is lacking. This means that an elderly woman living, for instance, in one of the buildings at the south end of the development, has a 5-mile walk (round trip) in order to do her shopping. Thus a mother of small children is effectively removed from supervising her offspring for a period of nearly 3 hours when marketing. But the design of these barns for the storage of unskilled laborers and their families is not that different from similar developments for the well-to-do, or the rich.

It is a strange paradox in the design field (at least in the United States) that as our families have become larger in size, and as the furniture and furnishing designed for us take up more space, the size of our houses or apartments, as well as of individual rooms, has shrunk unaccountably. As a family achieve